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Essays in Corporate Finance

Abstract

This dissertation studies the effects of informational asymmetries on corporate finance. Two distinct settings are considered, one empirical and one theoretical.

In the first chapter, I show that strong creditor rights facilitate the financing of innovation, using a novel dataset of patent collateral portfolios. Using the random timing of court decisions as a source of exogenous variation in creditor rights, I show that patenting companies raise more debt financing when they can more credibly pledge their patents as collateral. Consequently, R&D investment and patenting output also increase, as do the technological diversity and average citation count of the patents produced. These findings demonstrate that low leverage in innovative industries is due to information asymmetry, not incentive problems, and that a strengthening of creditor rights alleviates this friction by increasing collateral values.

In the second chapter, we identify three new factors that affect the firm's decision between equity issuance and asset sales in the presence of information asymmetry. First, equity investors own a claim to the capital raised, which mitigates the information asymmetry of the underlying balance sheet (the "certainty effect"). Second, firms can disguise the sale of a low-quality asset as instead motivated by dissynergies, and thus receive a higher price (the "camouflage effect"). Third, unlike with an equity issuance, a "lemons" discount on assets need not lead to a low stock price, as the asset is not a carbon copy of the firm (the "correlation effect"). The findings demonstrate that information asymmetry is a function of the nature and purpose of the firm's financing decisions.

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ABSTRACT

ESSAYS IN CORPORATE FINANCE

William Mann

Michael R. Roberts

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In the first chapter, I show that strong creditor rights facilitate the financing of innovation, using a novel dataset of patent collateral portfolios. Using the random timing of court decisions as a source of exogenous variation in creditor rights, I show that patenting companies raise more debt financing when they can more credibly pledge their patents as collateral. Consequently, R&D investment and patenting output also increase, as do the technological diversity and average citation count of the patents produced. These findings demonstrate that low leverage in innovative industries is due to information asymmetry, not incentive problems, and that a strengthening of creditor rights alleviates this friction by increasing collateral values.

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CHAPTER 1 : Creditor Rights and Innovation: Evidence from Patent Collateral

William Mann

Abstract

I show that strong creditor rights facilitate the financing of innovation, using a novel dataset of patent collateral portfolios. I begin by showing that secured debt is an important source of financing for innovation, and that patents are an important form of collateral supporting this financing. Since 2005, over one-third of aggregate R&D expenditures are by companies that have employed their patents as collateral. Using the random timing of court decisions as a source of exogenous variation in creditor rights, I show that patenting companies raise more debt financing when they can more credibly pledge their patents as collateral. Consequently, R&D investment and patenting output also increase, as do the technological diversity and average citation count of the patents produced. Analysis of the debt contracts reveals that covenants and collateral act as substitutes: When creditor rights strengthen, covenants loosen, granting firms more flexibility to invest in risky projects.

1.1. Introduction

Innovation is critical to economic growth, but its financing is inhibited by problems of moral hazard and adverse selection. These frictions lead to credit rationing, increased costs of capital, and an inefficient level of innovation (Hall and Lerner (2010)). I examine a contracting mechanism that mitigates these frictions: the use of patent portfolios as collateral for secured credit. Specifically, I ask whether stronger creditor rights encourage or discourage financing and investment for innovative firms. The answer is unclear: Strong creditor rights increase collateral value and thus financing capacity (Bester (1985)), but may discourage investment incentives as creditors are more able to capture the resulting surplus (Berkovitch et al. (1998), Acharya and Subramanian (2009)).

The link between creditor rights and innovation is particularly important to understand because secured debt is a growing means of financing innovative firms. I document this fact by constructing a comprehensive, hand-collected dataset of patent collateral portfolios. Companies employing their patents as collateral have performed 35% of R&D and 32% of patenting in Compustat since 2005. Of the stock of United States patents, 16% have been pledged as collateral at some point. Patent collateral is particularly important in innovative industries such as pharmaceuticals and software, in which firms often have few tangible assets but many valuable patents. These findings run counter to the conventional wisdom that intangible assets are not pledgeable, and they suggest that collateral value is an important consideration for innovative firms.

Building on this motivation, I study how the rights of secured creditors in default affect financing and investment by patenting firms. Secured creditors find it relatively difficult to enforce collateral claims against patents compared to other classes, so the legal system is effectively debtor-friendly for innovative firms (Amable et al. (2010), Stevens (2005)). I ask whether undoing this situation would primarily serve, *ex ante*, to encourage corporate innovation, by increasing collateral value and financing capacity for these firms; or rather would serve primarily to discourage innovation, by weakening employees' and equityholders'

bargaining power in case of financial distress, thus reducing their incentives to invest outside of distress.

Answering this question is challenging. Creditor rights are not randomly assigned across borrowers, but arise endogenously out of the legal and economic environment. I address this challenge using the random timing of four court decisions that clarified property rights to patents under United States law. Specifically, each decision elevated the importance of state law over federal law for patents. Some states provide stronger creditor rights than others, so the decisions represented a differential increase in creditor rights to patent collateral for borrowers incorporated in these states.

I find that the strengthening of creditor rights increased borrowing on both the intensive and extensive margins. Treated firms – those experiencing a strengthening of creditor rights to patent collateral – increased their level of long-term debt by 8% of firm total assets cumulatively in response to the four decisions, and they became increasingly likely to pledge their patents if they had not already done so. The finding suggests that lenders became more optimistic about the probability and speed with which they could recover pledged patents in case of bankruptcy, which in turn increased effective collateral value and financing capacity for patenting firms. In turn, patenting firms were willing to draw on that increased capacity. While these findings may seem natural, they were not inevitable: One might expect that innovative firms avoid borrowing when secured creditors are expected to have stronger bargaining power in financial distress. Alternatively, one might expect no significant effect if patents simply are not valuable collateral. Instead, my findings demonstrate that a strengthening of creditor rights to patents primarily served to increase access to collateral and thus the supply of credit to innovative firms.

I next show that this effect on financing translated into increased investment in innovation, as measured by R&D expenditure. Treated firms increased their annual R&D expenditure by 2.5% of total assets. The magnitude was roughly equal to the average annual effect on long-term debt, suggesting that patenting firms used the marginal credit from the in-

creased collateral value of their patents to finance research, and not simply to adjust their capital structures or to hold lower levels of cash. Taken together, the effects on borrowing and R&D demonstrate that lack of access to debt financing constrained investment in research by sample firms, and that increasing collateral values via strengthened creditor rights served to alleviate this constraint. Access to finance was more pressing than concerns about expropriation by creditors in default.

I further document heterogeneity in these findings based on several firm characteristics, providing supporting evidence for the conclusions offered so far. All effects were particularly pronounced for firms that had already pledged their patents as collateral prior to the court decisions. For example, treated firms with pre-existing patent-backed loans raised long-term debt by 2.8% more in response to the events compared to treated firms without such loans. Further, the effects were stronger for small firms, and for firms that operated in R&D-intensive industries. These subsamples represent the firms that are most likely to face credit rationing of innovative projects, and also the firms for which patents are important assets. Thus, the concentration of the effects in these three subsamples corroborates the conclusion that the court decisions primarily served to foster the financing of innovation, rather than to discourage borrowing or investment due to the risk of expropriation in distress.

The increase in treated firms' innovation investment, as measured by R&D expenditure, led a subsequent increase in innovation output, as measured by new patent applications filed with the Patent Office. This result was driven by small firms (those with less than \$100m in total assets). By 2008, the average firm in this subsample was producing 2.7 more patent applications per year (relative to a mean of 5). The new patents do not appear to have been low-impact, as the average number of citations received by new patents actually increased. Interestingly, the newly-produced patents also spanned more technology areas: The average number of technology areas in which a treated firm filed patents increased by 0.21 (relative to a median of one), suggesting that firms were able to pursue ideas that did not fit their existing focus, where lenders might otherwise have forced them to discard

these ideas in the absence of the downside protection provided by increased collateral value. In sum, stronger creditor rights led to increased innovation output, not only in terms of quantity but also in terms of quality and diversity. While the stronger negotiating position of creditors in the event of financial distress may have served to weaken this positive effect, as other firm claimants expected their firm-specific investments to be appropriated in this case, this concern was not strong enough to offset the benefits of increased collateral value of patent portfolios.

Finally, I explore an additional transmission mechanism connecting creditor rights with investment in innovation: the loosening of restrictive financial covenants that inhibited firms' risk-taking. When creditor rights strengthened, covenant structures loosened for treated firms. As a result, the annual ex ante probability of a treated firm violating a loan covenant declined by 11% relative to the rest of the sample (using the covenant strictness measure developed in Murfin (2012)). Borrowers and lenders appear to trade off ex post and ex ante creditor rights: Collateral value substitutes for the protection provided by tight covenants. In turn, a lower probability of violating a covenant represents real flexibility for the borrower's investment policy, because covenant violations are known to lead to reduced investment and R&D spending (Chava and Roberts (2008), Nini et al. (2009), Chava et al. (2013)).

In this setting, then, the primary effect of strengthened creditor rights was to alleviate constraints on the firm's financing capacity and investment policy, allowing the funding of more and higher-quality innovation. This conclusion stands in contrast to concerns that allowing creditors to exploit their superior bargaining power in financial distress leads to conservative investment policies ex ante – in this setting, a decreased willingness to fund risky, innovative projects. However, several prior studies have found evidence consistent with these concerns: Acharya and Subramanian (2009), Acharya et al. (2011), and Seifert and Gonenc (2012) show that countries with stronger creditor rights exhibit less secured financing and investment by innovative firms. Their conclusions would suggest that the

optimal bankruptcy policy balances a desire to create credit for non-innovative industries against a desire to encourage risk-taking in innovative industries. In Section 1.5, I explain how differences in our institutional settings can reconcile our results, which has implications for the policy conclusions of this study.

The paper also contributes to a growing literature on collateral for innovative industries and low-tangibility firms. Amable et al. (2010) note the difficulty of enforcing a security interest against patents, and develop a model that suggests that this is an important constraint on aggregate innovation. I offer empirical evidence consistent with this hypothesis. Loumiotis (2012) uses a sample of Dealscan loans and a field study of lending practices to examine the role of asset redeployability and borrower reputation in the use of intangible assets as collateral, as well as the terms and performance of intangibles-backed loans. I introduce aggregate data on patent collateral, demonstrate its importance to research investment, and focus on the role of creditor rights in its effectiveness. Falato et al. (2013) and Brown et al. (2009) show that investment by research-intensive firms relies heavily on cash holdings and equity financing, respectively. My paper documents the increasing ability of patent-backed debt to support innovation investment, which could potentially allow these firms to forego stockpiling cash or waiting for “hot” equity markets in order to obtain financing.

The remainder of the paper is organized as follows: Section 1.2 describes my data sources and uses them to offer some motivating stylized facts. Section 1.3 explains my identification strategy and the sample used in the analysis. Section 1.4 presents and discusses the results. Section 1.5 discusses my findings in the context of previous studies, and Section 1.6 concludes.

1.2. Data

I begin by constructing a novel dataset listing patents pledged as collateral for secured loans since 1976. When a lender accepts a patent as collateral, it files a notice of that fact with the United States Patent and Trademark Office (USPTO). This is done to provide notice

to potential future purchasers that a claim exists against the patent, while the separate issue of perfecting the security interest is governed by state filings (see Stevens (2005)). These USPTO records have recently been published online as flat files through the Google Patents project. From these files, I assemble a dataset containing the date, patent number, borrower name, and lender name for each pledge of patents as collateral for a loan. I match all possible events with Compustat companies by name. Details of this process are in Section 1.8.1.

I combine this dataset with firm-level data on patent applications, grants, transfers, citations, and classifications. I begin with the data from the NBER Patent Data Project, which currently ends in 2006, and I extend it to the present using USPTO documents available online. Firm identifiers are assigned by string comparison of the patenting company with the existing NBER identifiers, and companies are then matched with Compustat using the linking file provided by the NBER, carrying the links as of 2006 forward to subsequent years. Further details are in Section 1.8.2.

I also obtain covenant structures for sample firms' debt contracts wherever possible from the Dealscan database, matching these observations to Compustat using the linking file developed in Chava and Roberts (2008). I augment this sample by performing an automated search of SEC filings on the EDGAR system. My algorithm identifies loan origination and amendment documents, extracting their dates and their effects on covenant thresholds. I focus on the the five most common financial covenants in Dealscan – interest coverage ratio, leverage ratio, debt service coverage ratio, fixed charges coverage ratio, and current ratio – and I use these to construct the Murfin (2012) measure of covenant strictness, which captures the probability that a firm violates one of its covenants within the next three months. Details are in Section 1.8.3.

1.2.1. Stylized facts about patent collateral

I first use the data to offer three stylized facts about the market for patent-backed loans that motivate my analysis:

First, the aggregate frequency of patents being pledged as collateral is growing. Figure 1a in the Section traces the increase over time in the frequency of this financing, to roughly 36,000 patents pledged per year in recent years. Figure 1b shows that about 15% of patents from a typical vintage are pledged as collateral within five years of being granted, a number that has also risen steadily. I do not generally observe the amount of the loans, nor the other components of the collateral portfolio, but Loumioti (2012) reports that the dollar proportion of Dealscan loans collateralized by intangible assets (including non-patent intangibles, but excluding all-asset liens) increased from 11% to 24% during 1997-2005. Given the rapid growth of patent-backed financing, the sparsity of empirical evidence on the collateral value of patents is an important gap that I aim to fill.

Second, the flow of credit from these deals is economically large and directly finances research. Figure 2 shows that, for Compustat-listed borrowers in high-R&D industries, long-term debt issuance and R&D expense both increase substantially as a proportion of total assets (10% and 6% respectively) in the year when a firm borrows against its patents. Table 1 shows that the median ratio of loan value to firm total assets in Dealscan is 28%. Thus, many economically large secured loans include patents in the collateral portfolio, and this financing coincides with increased research investment. Moreover, the firms that borrow against patents perform a major share of aggregate investment in innovation: Figure 3 demonstrates that over a third of domestic patenting and R&D by US firms in recent years is performed by companies that have previously pledged patents as collateral.

Third, patents themselves are often an economically important source of collateral value, and are not merely an afterthought for high-tangibility firms that pledge all their assets simultaneously. This is important if my study is to inform innovation policy, because many

innovative firms have few other assets to pledge. Figure 4 displays the top ten industries by 3-digit SIC code among Compustat-matched borrowers. These are all low-tangibility, research-intensive industries in which patents are particularly important assets. Brown et al. (2009) show that seven of these ten industries account for nearly all of the growth in aggregate US R&D expense since the early 1990s. (Subsequent results will show that these seven industries are also particularly responsive to a strengthening of creditor rights.)

Individual examples also illustrate that patent collateral can be valuable for credit-constrained, innovative firms: Insite Vision, a developer of optical pharmaceuticals, raised \$6 million of debt financing in 2005 (more than the total assets reported on its balance sheet) by pledging its patent portfolio as collateral. The money financed clinical trials, and the company warned investors that restrictive debt covenants or lack of access to debt finance might inhibit future product development. Scientific Learning, an educational software company, added patents to its collateral portfolio after deteriorating financially and violating a loan covenant. Its lender simultaneously reduced the amount of the loan, but presumably the additional collateral kept the consequences from being worse. These examples and others are described further in Section 1.7.

Finally, my empirical strategy will also demonstrate that patent collateral is economically valuable, because the events that I study affect creditor rights for patent collateral alone. If patents are not valuable collateral, I would expect to see no large impact on firm behavior in response. Thus, my findings will offer evidence on the economic importance of patent collateral to innovation financing and investment.

The existence of a market for patent-collateralized loans is puzzling from a theoretical perspective: Patents support risky firms; they are difficult for lenders to value or sell; and they are difficult to seize in default relative to tangible assets. All three of these constraints are commonly cited as reasons that secured debt is not typical for innovative firms (Hall and Lerner (2010)). In the remainder of the paper, I examine the third of these factors – the weakness of creditor rights in default – and I demonstrate that a strengthening of

creditor rights has significant effects on financing and investment in innovation, suggesting that this can be a valuable target for policies attempting to increase access to finance for innovative firms.

1.3. Identification strategy

The goal is to examine the effect of strengthened creditor rights on financing and investment by innovative firms. This effect is difficult to identify, because creditor rights are defined by laws that arise in response to complex and unobservable factors, making it difficult to claim causality in any observed association. For example, if companies in states with stronger creditor rights raise more funds against their patent collateral, this could reflect unobserved characteristics of those states that also motivated the provision of stronger creditor rights in the first place.

The development of patent-related caselaw provides an empirical setting that addresses this identification concern. A series of court decisions has limited the extent to which federal law overrides state law with respect to contractual and property rights for patents. Some states provide stronger creditor rights than others, via pro-creditor laws that protect the transfer of collateral to bankruptcy-remote entities. Thus, when the court decisions increased the importance of state law for patents, borrowers in the pro-creditor states experienced a relative strengthening of creditor rights to patent collateral.

Intuitively, my approach recognizes that creditor rights are defined not only by legislatures, but also by courts. The passage of pro-creditor laws in certain states was likely endogenous to the specific conditions of those states. The court decisions, by contrast, arose in response to idiosyncratic corporate circumstances. Moreover, they were all decisions by federal courts, not state courts (two by bankruptcy courts and two by the Federal Circuit Court of Appeals) – their effect was on national perceptions about the importance of state law for patents. Thus, their timing and outcomes are more plausibly exogenous than the actions of state legislatures with respect to differential changes around the event dates

between firms incorporated in pro-creditor states and other firms.

This section briefly describes the empirical approach. I summarize first the court decisions that elevated the role of state law with respect to patents, then the laws that make some states more pro-creditor than others, and finally the sample of firms and the regression specifications.

1.3.1. Court decisions

The four decisions had a common theme: the preemption of state law by federal law with respect to patents. Contracts and property rights are generally a matter of state law, both inside and outside bankruptcy; but when an asset class is governed by federal law (as patents are, by the Patent Act and by the body of federal common law emanating from it), that law may implicitly override state law. Uncertainty about the extent to which patent law overrides state law has been pervasive (Young (2008)) and has been a major constraint on the growth of the patent-backed loan market (Amable et al. (2010), Stevens (2005)).

I searched for court decisions since 2002 that have addressed the scope of patent law in preempting state law, and found four. Each ruled, for the issue at hand, that the language and intent of patent law were relatively narrow, and thus did not override state law. Each has attracted commentary for this ruling, suggesting an emerging consensus that courts will generally interpret state law to apply to patents consistently with other asset classes, although the general question can only be addressed on a case-by-case basis, never completely settled. (In contrast to this trend, the Copyright Act has been found to preempt state law more broadly; see McJohn (2010) and the decision in *In re Peregrine Entertainment*.) The endnotes to this document provide further discussion of each case.

The first decision, dated March 26, 2002, concerned the bona fide purchaser defense, which is generally governed by state law but is partially addressed by the Patent Act. This raised the broader issue of the Patent Act's scope to preempt state law. The Court of Appeals for the Federal Circuit articulated a narrow approach to creating federal common law for

patents, with the goal of harmonizing as closely as possible with the state law governing other asset classes. In doing so, the court overturned a previous decision that had more broadly applied a federal common-law precedent.¹

The second decision, dated May 30, 2003, included two separate rulings that narrowly interpreted federal patent law with respect to contracts and property rights. First, the New Hampshire District Court denied that patent law implicitly redefines a limited sale as a license. Second, the court ruled that a state filing is necessary to perfect a security interest in a patent (that is, the availability of the Patent Office registry does not imply that Congress intended to replace state-level filing systems). The decision is usually cited for the latter ruling.²

The third decision, dated May 15, 2007, also included two separate rulings. First, the Massachusetts District Court ruled that the Patent Act’s registry for patent ownership does not create an ability to “perfect by possession” that circumvents state-law requirements for perfection of security interests. Second, the court ruled that a state filing is sufficient for perfection of a security interest, building on previous decisions holding that a state filing is necessary.³

In the fourth decision, dated August 20, 2009, the Court of Appeals for the Federal Circuit

¹*Rhone-Poulenc Agro v Dekalb Genetics*, decided by the United States Court of Appeals for the Federal Circuit (on appeal from the United States District Court for the Middle District Court of North Carolina), March 26, 2002. The decision is often cited for the phrase “the interpretation of contracts for rights under patents is generally governed by state law” (see, for example, Gibbons (2004), Rosenstock (2005), and Young (2008)). In particular, the case emphasized that its ruling was consistent with North Carolina law, which would have governed if not for the conflict with federal patent law. By contrast, the previous decision, in 2001, stated that the bona fide purchaser defense “was governed by federal law – in this case, federal common law. Hence it was irrelevant of the law of the state in which the district court was located did not recognize such a defense.” Ziff (2002), published between the two decisions, cites the first as an example of expanding federal preemption of state contract law, while Young (2008), published later, mentions the ruling as an example of the general supremacy of state contract law for patents. The discarded precedent in federal common law was from *Heidelberg Harris v Loebach*, 1998.

²*In re Pasteurized Eggs Corporation*, decided by the United States Bankruptcy Court for the District of New Hampshire, May 30 2003. Cited, for example, by Menell (2007). Also see *Securitization of Financial Assets*, ch. 6 p 6-71. The perfection-related ruling represented the adoption of a 1999 precedent from a different jurisdiction (Cybernetic Services). This case and Cybernetic both contrast their findings with the Copyright Act, which explicitly overrides state filing systems for perfection of security interests.

³*In re Coldwave Systems LLC*, decided by the United States Bankruptcy Court for the District of Massachusetts, May 15, 2007. See discussion of the “perfection by possession” issue in McJohn (2010).

ruled that foreclosing on a patent through state procedures is sufficient to effect a transfer of ownership, as with other asset classes. That is, the Patent Act does not create any special requirements for this process. McJohn (2010) argues that the emphasis on state law in this ruling will facilitate the use of intellectual property as collateral.⁴

1.3.2. *Pro-creditor state laws*

The elevation of state law for patents plausibly affected creditor rights differentially across states because some states provide stronger creditor rights than others. These rights come from a set of pro-creditor laws that were passed starting in 1997 in an effort to promote secured lending. They provide contractual autonomy to loan parties to separate collateral from the borrower’s estate in bankruptcy. The laws are amendments to the Uniform Commercial Code and are the only significant non-uniformity across states in secured lending law (Janger (2003)). The language of these laws is remarkably simple and broad. The full text of Delaware’s law is reproduced as Section 1.9, and the wording varies little from state to state.

The autonomy provided by these laws does not exist in other states, where bankruptcy judges may rule that the “sale” of collateral to a subsidiary or special-purpose vehicle was not a “true sale.” The best-known case on the true sale issue, *Paloian v LaSalle*, illustrates the difficulty this creates for secured lending: The bankruptcy has gone through multiple rounds of hearings trying to determine whether a borrower successfully removed collateral from its balance sheet. (Notably, the “securitization” in this case was a \$25 million revolving line of credit, demonstrating that the issue arises beyond the typical connotation of the term securitization.) A July 2013 opinion from the case suggests that the pro-creditor laws could have aided the creditor in this case, but they do not apply, since Illinois law governs.

Anecdotal evidence suggests that the laws have not attracted much securitization business away from other states (Lipson (2004)), but my paper is, to my knowledge, the first formal

⁴*Sky Technologies v SAP AG and SAP America*, decided by the United States Court of Appeals for the Federal Circuit (on appeal from the United States District Court for the Eastern District of Texas), August 20, 2009.

study of their effect. Also, I focus on innovative industries and small firms, which are plausibly more credit-constrained and more likely to respond to the presence of such laws than the firms or industries that account for the biggest securitization deals. Kieff and Paredes (2004), for example, suggest that these laws can be useful in principle for patent-backed financing specifically. The states that have passed the laws are listed in Table 3, along with the first full calendar year in which each state’s law was in effect (the exact legislative history of each bill is not available).

With these laws present in certain states, the intuitive effect of the court decisions previously outlined was to increase the probability that patents held in a distinct legal entity from the borrowing firm would be respected in bankruptcy as no longer being that firm’s property. This allows secured lenders to recover collateral with greater speed and reliability in bankruptcy, since the separate entity need not file for bankruptcy and automatic stay protection. The pro-creditor laws require firms to opt in to this greater degree of creditor protection, but creditors are likely to be able to force borrowers to opt in to this provision as the firms near financial distress. That is, in the presence of incomplete contracts, when stronger creditor rights are available, they are also effectively mandatory, a point made in the models of Berkovitch et al. (1998) and Acharya and Subramanian (2009) among others.

An ideal experiment would be a court decision that directly addresses the applicability of the pro-creditor laws to patents, but the laws have not yet been tested in any court setting. This fact means that the best available identification strategy is to investigate instead the effect of the decisions studied here, which address more generally the applicability of state law for patent contract and property rights. It also means that these decisions represent the best guidance that loan parties themselves have received on the same issues.

1.3.3. Sample construction

The dataset starts with quarterly Compustat data, restricting to companies headquartered in the United States (FIC code “USA”), and excluding companies in SIC industries starting

with 0 (agriculture, forestry, and fishing), 6 (finance, insurance, and real estate), or 9 (public administration). This quarterly firm panel is converted to a monthly panel by copying level variables (such as assets and debt) for each month in the fiscal quarter and dividing flow variables (such as R&D expense) evenly over each month in the quarter. Monthly observations of patent applications, patent grants, and pledges of patent collateral are merged in from the datasets described in Section 1.2.

Finally, for a given event window, the sample is restricted to companies that were present in Compustat as of the beginning of that event window and that had received at least one patent grant in the ten years prior. I employ two event windows in the analysis: The first starts twelve months before the first decision (in April 2001), includes the first two decisions, and ends eighteen months after the second (in November 2004). The second starts twelve months before the third decision (in May 2006), includes the last two decisions, and ends eighteen months after the last (in February 2011). The treated group is the subset of companies incorporated in states with pro-creditor laws of the kind described in the previous section. (Section ?? explains why the state of incorporation is the relevant state for determining treatment status.)

I also remove from the sample one company, Igene Biotechnology, which averages long-term debt of over ten times total assets throughout the first event window. This average is greater than the maximum attained by any other firm-month in the sample. Accounting statements on EDGAR seem to verify the numbers reported in Compustat, but this gives the company tremendous influence on the mean long-term debt level of untreated firms. Including the company in the sample increases the mean and volatility of long-term debt for untreated firms, but otherwise does not affect the findings.

An important subsample in the analysis is firms in research-intensive industries (referred to as “High-R&D” firms in the tables). These industries are defined by a list of seven 3-digit SIC codes identified in Brown et al. (2009), who show that these industries account for nearly all of the growth in US R&D investment during the 1990s. The industries are

drugs (SIC code 283); office and computing equipment (357); communications equipment (366); electronic components (367); scientific instruments (382); medical instruments (384); and software (737). Section 1.2.1 showed that each of these industries is among the top ten in which companies pledge patents as collateral, motivating the hypothesis that patent collateral value can be an important means of financing research. High-R&D companies account for 51% of the sample.

Other subsamples of interest are small companies and companies that are known to have pledged their patents as collateral in the past. In the reported results, small companies are defined as those with less than \$100m in total assets, which account for 37% of the sample. Companies that have pledged their patents account for 18% of the sample. In both cases, these cross-sectional variables are measured as of the beginning of an event window, so that companies do not change assignments between subsamples during the window.

The final sample contains 1,963 unique sample companies, of which 67% are incorporated in states with pro-creditor laws, and are thus treated by the court decisions. (The high fraction of treatment is due to Delaware’s law, which also yields a great deal of variation in the physical location of treated companies.) Table 5 presents a comparison of the treated and untreated companies across several financial variables for the first event window. Only one variable presents a significant difference: Treated companies expend about 3% more of total assets on research and development (although the levels of R&D and of assets separately are not significantly different). The ratio of R&D to total assets is an outcome variable studied in the analysis, but the results will demonstrate that it follows a parallel trend between treated and untreated firms at the beginning of each event window, so the difference-in-difference approach can still identify a causal effect.

1.3.4. Specifications

For outcome variables which plausibly respond quickly to a strengthening of creditor rights, such as long-term debt and R&D investment, treatment effects are examined within a short

window around the events. Given the timing of the four court decisions, they are grouped into two pairs, yielding the two event windows mentioned before. The first of the two event windows stretches from April 2001 through November 2004, and the second from May 2006 through February 2011. The basic regression with a full set of monthly dummies would be as below:

$$y_{ism} = \gamma_i + \sum_{m=\text{May '01}}^{\text{Nov '04}} \delta_m + \sum_{m=\text{May '01}}^{\text{Nov '04}} \beta_m \times \mathbb{1}\{law\}_s + \epsilon_{ism} \quad (1.1)$$

Here i indexes firms, s states of incorporation, and m months. γ_i is a firm dummy, while δ_m and β_m are both time dummies that turn on in month m , and $\mathbb{1}\{law\}_s$ is an indicator equal to 1 for companies incorporated in states with a pro-creditor law. Thus β_m captures the treatment effect in month m .

For compactness, the regression tables will aggregate the time dimension from this specification to a coarser frequency. These specifications focus on one event window at a time (one pair of events), so the regressions are of the form

$$\begin{aligned} y_{ism} = & \gamma_i + \delta_1 \times \mathbb{1}\{\text{between first and second decisions}\}_{im} \\ & + \delta_2 \times \mathbb{1}\{\text{after second decision}\}_{im} \\ & + \beta_1 \times \mathbb{1}\{law\}_s \times \mathbb{1}\{\text{between first and second}\}_{im} \\ & + \beta_2 \times \mathbb{1}\{law\}_s \times \mathbb{1}\{\text{after second}\}_{im} \\ & + \epsilon_{ism} \end{aligned} \quad (1.2)$$

Thus β_1 captures the treatment effect of the first decision alone, before the second decision is released. β_2 captures the cumulative treatment effect of both decisions following the release of the second.

For variables likely to respond more gradually, treatment effects are obtained by year:

$$y_{isy} = \gamma_i + \sum_{y=2001}^{2011} \delta_y + \sum_{y=2001}^{2011} \beta_y \times \mathbf{1}\{law\}_s + \epsilon_{isy} \quad (1.3)$$

However, the panel is still at a monthly frequency, so that the interpretation of all reported coefficients is consistently a monthly effect.

All standard errors are clustered by state of incorporation, the level at which the treatment indicator varies. Since treatment status is constant for a given firm, this clustering also addresses potential serial correlation in the residuals of the specification.

1.4. Results

1.4.1. Debt financing

The first set of results demonstrates that firms increased their level of long-term debt in response to the strengthening of creditor rights to patent collateral represented by the court decisions.

I begin with the first of the two event windows described earlier, which stretches from April 2001 to November 2004. Panel (a) of Figure 5 displays the sample means of long-term debt scaled by total assets for the treated and untreated companies throughout this window. The means for these two subsamples tracked each other closely leading up to the release of the first court decision, but then diverged sharply, with treated companies increasing their average debt financing while the untreated companies continued their downward trend. By 2004, the subsample means were again moving in tandem, but the level for treated firms was about 3% of total assets greater than that for untreated firms.

Panel (b) of Figure 5 restates this finding as a plot of the coefficients from the corresponding difference-in-difference regression (the figure plots the monthly interaction coefficients β_m from Specification (1.1), along with 95% confidence bounds). The difference between the two groups began to increase after the first decision release date and leveled off by November

2004 at about 3% higher than the initial difference. Table 6 continues this regression analysis, replacing the monthly dummies with coarser time dummies that change only at the months of court decisions, as in Specification (1.2). Column (1) of Table 6 restates the results from Figure 5 by omitting the firm fixed effect γ_i and including instead a treatment indicator $\mathbb{1}\{law\}_s$. Column (2) introduces the firm fixed effect, showing that the effect was still positive and significant within-firm, although the magnitude was slightly smaller, for a cumulative increase in long-term debt of about 2.5% of firm total assets.

These results demonstrate two important findings: First, on the supply side, the strengthening of creditor rights significantly increased the amount of credit available to innovative firms. Intuitively, when lenders expected to recover patents in bankruptcy more quickly and reliably, the effective collateral value of those patents increased, so credit supply to patenting firms also increased. While the direction of this effect is unsurprising, the magnitude is quite large: The median sample firm had \$200m in total assets as of April 2001, and so was able to raise \$5m in new long-term over the next three years, relative to initial long-term debt of \$6.6m. Second, on the demand side – and returning to the main question posed by this paper – innovative firms were willing to access this increased credit supply. Managers were not concerned about increasing their debt level and probability of distress, even though this would now result in greater bargaining power accruing to the firm’s creditors. At least, such concern were not strong enough to outweigh their need for funds.

Column (3) restricts to the subsample of firms that was observed to have pledged patents as collateral at some point in time prior to April 2001. The effect on their debt financing was particularly strong, both in the short term (between the first two events) and in the long term (after the second event). Intuitively, these firms had demonstrated the importance of patent collateral to their financing, as they already had debt agreements employing that collateral. Thus, as shown in Column (3), an increase in the collateral value of patents directly increased the levels of debt these firms were able to maintain: The cumulative effect of the first two decisions on long-term debt financing for these firms was 4.5% of total

assets, compared with a 2.5% effect in the full sample. This finding provides corroborating evidence that the identification strategy captures an increase in the collateral value of patent portfolios.

(One might then expect, as a falsification test, that there should have been no effect on companies that were not observed to pledge their patents as collateral. This is not the case, since lenders sometimes fail to register their security interest with the USPTO, which would prevent me from observing the pledge of the patents. However, the effect was substantially weaker for borrowers not observed to pledge, at around 2% of total assets by the end of the event window.)

Column (4) further demonstrates that the effect was stronger for relatively small firms, defined as firms with less than \$100m in total assets. Since small firms face greater financing constraints on their investment than large firms (Hadlock and Pierce (2010)), this result further substantiates that the events served to ease financing frictions by increasing the collateral value of patents: Access to finance for smaller firms is more constrained by access to collateral than for larger firms. (Unreported results show that this result also holds for alternative measures of size such as sales.) This finding is also important for the interpretation of the results, as several prior studies suggest that research investment by small firms is both more productive and more important to technological progress than research investment by large firms (see Cohen (2010) for a review).

Finally, Column (5) demonstrates that the effect was also stronger for firms in high-R&D industries (defined as in Section 1.3.3) relative to the full sample. Again, this finding corroborates the interpretation that the strengthening of creditor rights led to an increase in patent collateral value and a consequent easing of financial constraints. R&D investment is more financially constrained than other types of investment, so firms in industries that mainly invest in the form of R&D are likely to be more limited in terms of access to finance, and thus to benefit more from an increase in collateral values. They are also the firms most likely to own valuable patent portfolios in the first place.

I next repeat the analysis for the event window containing the last two decisions. The sample is re-constructed according to the same procedure as with the first window. (A comparison of the resulting treated and untreated subsamples, as in Table 5, is presented in Table 13 in the Section.) Figure 6 then repeats the analysis that was presented in Figure 5 for the first event window: As in that figure, debt followed a parallel trend for the two subsamples leading up to the first decision in the window (although they started at different levels, reflecting the effect of the first pair of events), then began to diverge after this point. Table 7 repeats the regression specifications, and the results uniformly echo the findings from the first set of decisions.

In sum, the relative strengthening of creditor rights represented by the four court decisions allowed innovative, credit-constrained firms to raise more debt financing, because the collateral value of their patent portfolios increased. Having established this financing impact, I now show that it led in turn to increased investment in research.

1.4.2. Investment in research

This section repeats identically the analysis of the previous section, only replacing the outcome variable with monthly R&D expense scaled by total assets. (As described in Section 1.2, monthly R&D is calculated by evenly distributing quarterly R&D for each month in a fiscal quarter.)

Figure 7 demonstrates the evolution of the sample means of monthly R&D scaled by assets around the first two event dates, separately for the treated and untreated subsamples. As noted in Section 1.2, the two subsamples started at different means, but they tracked each other closely, validating the parallel trends assumption behind a difference-in-difference analysis. Throughout the event window, the untreated group continued a downward trend, but the treated group gradually increased away from this counterfactual and ultimately leveled off at a higher monthly investment in R&D.

The final difference was about 0.1% of total assets in R&D expenditures per month, or

1.2% per year, relative to the annual mean R&D expense of 14% of total assets presented in Table 5 for the treated group at the beginning of the event window. The previous section demonstrated a 3.3% increase in long-term debt in response to the strengthening of creditor rights over a period of about three years, so the magnitudes suggest that the marginal debt financing went almost entirely towards R&D investment. This finding demonstrates that investment in research was credit-constrained for sample firms, and that an increase in collateral values due to greater pledgeability of patents allowed treated firms to invest in new research, or to scale up investment in old research, that otherwise would not have been undertaken.

As before, Table 8 continues this analysis in a regression framework, using the same specifications and subsamples as in Tables 6 and 7 previously, with only the outcome variable changed. Small firms, firms in high-tech industries, and firms that had previously pledged their patents as collateral all exhibited stronger impacts of strengthened creditor rights on R&D investment compared to the full-sample specification with firm fixed effects reported in Column (2), as was the case with the increased level of long-term debt. This corroborates the interpretation of a causal impact from creditor rights to financing capacity and finally to investment. Finally, Figure 8 and Table 9 present consistent results for the event window centered around the third and fourth events.

The cumulative average effect of all four events on a treated firm was a 2.5% increase in annual R&D expense as a fraction of firm total assets (the sum of the second interaction coefficients from Column (2) of Tables 8 and 9, multiplied by 12). In dollar terms, the median firm had \$203 million in total assets in 2001, and thus was able to spend \$5 million more on R&D per year than it otherwise could have, relative to a 2001 median of \$6 million of R&D expense per year. To get an aggregate magnitude, calculating the effect at the full-sample mean would yield misleadingly large results, since the table shows that the increase was concentrated among smaller firms. Instead, I sum the effect over 20 bins of firm size (by total assets) and find an aggregate increase of \$13 billion in R&D expense per year in

response to the four decisions, relative to \$113 billion of R&D undertaken by sample firms in 2001.

Overall, the results on debt financing and R&D investment provide compelling evidence that a strengthening of creditor rights to patent collateral provided small, innovative, and credit-constrained firms with increased access to capital, which was then allocated towards increasing the scale of R&D investment. These findings suggest that credit rationing is a more important factor than the bargaining power of creditors for the investment decisions of innovative firms: Even though the strengthening of creditor rights increased the degree to which creditors could expropriate profits from innovative investments in response to any future financial distress, sample firms were still increasingly likely to fund those investments, because they also had greater financing capacity thanks to increased patent collateral value.

To complete the narrative, I next demonstrate effects on several outcome variables that responded more gradually: the creation of new collateral claims against patents, the production of new patent applications, and the strictness of accounting covenants written into the debt contracts backed by patent collateral.

1.4.3. Use of patents as collateral

The previous sections have demonstrated that an increase in the pledgeability of patents increased their collateral value, allowing firms that had employed their patents as collateral to raise more debt financing and invest the proceeds in research. This section will demonstrate the natural corollary: Firms that had not previously pledged their patents as collateral were increasingly likely to do so in response to their increased pledgeability, because lenders were increasingly willing to accept this collateral.

To demonstrate this, the outcome variable in this section is an indicator for whether a firm has ever been observed to pledge its patents as collateral (the same variable that was used to condition the subsample in Column (3) of the previous tables). The growth of this variable over time reflects firms “entering” the patent-backed loan market by pledging their patents

as collateral for the first time. Figure 3 traced the level of this variable over time, which is mechanically increasing; but this section will establish that the increase among treated firms accelerated relative to untreated firms in response to the strengthening of creditor rights to patents.

The level of the variable for the treated and untreated subsamples from 2000-2011 is displayed in Panel (a) of Figure 9. Two features are of note: First, the two subsamples tracked each other closely prior to the first event. Second, a discrepancy opened up between the two groups sometime between or after the first two events, with firms in the treated group continuing to enter the patent-backed loan market at a steady clip while the growth of the market for untreated firm slowed down. Once again, the effect was particularly pronounced for small and R&D-intensive firms, as displayed in Panel (b). There was another sharp relative increase in the growth rate for treated firms following the third event in Panel (b), but this growth seems to have leveled off in more recent years, while untreated firms have begun to catch up.

To capture this gradual increase in a regression framework, Table 10 extends the sample of firms to the window from 2000 to 2011, and reports regressions analogous to those in the previous tables, using yearly dummies as in Specification (1.3). As with the previous variables, the results were stronger for R&D-intensive firms than for the full sample. They were also particularly strong for small firms (in fact, these are the only columns in which the interaction terms are significant). Again, these results not only conform well with the interpretation that stronger creditor rights eased financing constraints, but also imply that the findings of this study are important for understanding technical progress in the economy, since research by small firms is a particularly important source of innovation driving that progress.

In conclusion, the increased enforceability of collateral claims against patents resulted in an expansion of the availability of patent-backed financing to a greater number of patenting firms. In particular, small and research-intensive firms were able to pledge their patents in

much greater numbers than they otherwise could have done, as demonstrated by Panel (b) of Figure 9, when lenders were more confident of their ability to foreclose against patents in default. Next, I show that the financing and investment findings had real impacts on firm innovation output.

1.4.4. *Patenting output*

The preceding results have shown that a strengthening of creditor rights to patent collateral increased access to finance and investment in R&D for patenting firms. This section shows that, in turn, small patenting firms also increased the volume, diversity, and quality of their output of new patent applications.

Research on patenting avoids using patent counts as an outcome variable in an OLS specification, because the extreme overdispersion of this variable means that estimates are heavily influenced by the behavior of a few companies filing many patents. Popular alternative approaches include replacing the patent count with its natural logarithm or estimating a Poisson regression via quasi-maximum likelihood. Results from either approach can be interpreted as percentage effects on firm patenting output. (See Hausman et al. (1984) for a discussion.) My approach is to scale the firm's monthly patenting output by the total number of patent grants it has received over the previous ten years. This is always feasible, since my sample consists of firms that have actually received a patent over the previous ten years. As when financial variables are scaled by financial measures of firm size, this means that the influence of a firm's patenting activity on OLS coefficients scales naturally downward for firms that regularly produce more patents. The result is thus interpreted as an effect on the firm's patenting *intensity* – the number of new patents it produces each month as a percentage of its ten-year patenting history.

The findings of this section are summarized in Table 11, which repeats a regression similar to that in Table 10, using patenting-related variables as the outcome. The sample is the set of firms that had total assets less than \$100m as of April 2001. In Column (1), the

dependent variable is the firm’s monthly patenting intensity, as described above. Treated firms gradually increased the intensity of their monthly patenting activity: By 2008, they were producing 2.5 more new applications each month per 100 patents granted over the past 10 years relative to the untreated set of firms. The average 10-year patenting total in this subsample is 9, so this represents 2.7 additional patent applications filed per year, relative to an average of 4.7 among firms in this subsample that filed any applications in 2008. This finding is evidence that a strengthening of creditor rights led to an increase in innovation output by small firms. Column (2) demonstrates, as with the previous findings, that this effect was even stronger within the research-intensive industries highlighted earlier in the paper.

Columns (1) and (2) end the analysis in 2008 because, after this point, the right-truncation of patenting observations mechanically causes the estimated coefficients to decline to small or negative numbers. That is, since I only observe patent applications once they are granted, and the review of the application by the USPTO introduces delay into this process, the number of applications observed per year shrinks to zero by the present (this is depicted by Figure 11b in Section 1.8.2). In turn, any differences in mean patenting output across the treated and untreated subsamples also shrink to zero by this point, which would give the false appearance that the treatment effect disappeared in later years.

Aside from simply dropping the later years, there are alternative ways to deal with this issue. The Patent Office reports each year the aggregate number of applications made by domestic companies, so I know the fraction of aggregate patenting that is unobserved due to right-truncation. I use this fraction to re-weight firm-level patenting, implicitly assuming that the same degree of right-truncation applies to all firms within a given year. This is appropriate under the assumption that treated firms do not systematically file applications subject to different approval delays. The resulting inflation factor starts at 1.98 in 2000 and rises steadily to 5.71 in 2008. By design, the aggregate trend of this rescaled application output tracks the USPTO-reported aggregate application numbers instead of declining to

zero at the present.

Column (3) of 11 applies this rescaling to the result from Column (2). With this adjustment, the estimated treatment effects are naturally larger, suggesting that treated companies were producing 28 more patents per year by 2008 relative to a subsample mean of 27. More importantly, the effect was sustained until the end of the sample, which would not have been the finding without rescaling to deal with right-truncation. Furthermore, for this outcome variable, a significantly positive treatment effect was evident across the whole sample, as demonstrated in Column (4), and not just for the small firms studied in the rest of the table that exhibited the strongest effect on patenting output. Panel (a) of Figure 10 plots the mean rescaled patenting intensity for treated and untreated firms in the full sample from 2000 through 2011.

Column (5) demonstrates that treated firms not only filed more patents, but also filed patents in more technology areas. “Technology areas” refers to 37 patenting technology subcategories developed in Hall et al. (2001) that subdivide the six main categories alluded to previously (as in Figure 1a). For the set of small firms considered in this section, conditional on filing patents in a given month, the minimum and median number of subcategories filed per month are both 1, and the maximum is 6. Nevertheless, Column (5) demonstrates that treated firms became increasingly likely to patent in more than one category: The average number of categories in which a firm filed patents each month increased by 0.21.

This finding is striking, because it suggests that not only the volume but also the type of innovation produced by patenting firms responded to a strengthening of creditor rights. A plausible mechanism for this finding is that patenting in a new area involves both greater risk and greater return for the patenting firm than remaining in its prior space, and that firms are better able to undertake risky investments when lenders have greater protection in bankruptcy, because lenders ease loan terms that otherwise restrict investment risk. One might instead believe that patenting diversity is associated with *lower* firm risk, but investment in new research areas requires new expertise as well as time, and the resulting

cash flows (and their correlations) are far from certain. I will offer more evidence on the connection between loan terms and project risk in the next section when examining the strictness of financial covenants.

Finally, a common concern with patenting studies is that not all patents are equally important. In this context, one might be concerned that firms produced meaningless patents simply to take advantage of the greater legal significance of intellectual property rights when creditor rights strengthened, hoping that lenders would accept the worthless new patents as collateral either through naivety or as a potential weapon for litigation. To provide some evidence on this concern, in Column (6) I use as a dependent variable the average number of citations received by a firm's monthly patenting output within the next five years. (Citations are a commonly-used proxy for the impact or social value of a patent.) Far from decreasing in impact, the patents produced by small firms seemed if anything to receive more citations, an effect that strengthened over time.

A related interpretation of the results is that firms were not actually producing valuable innovation in greater volumes, but rather were more likely to label a given valuable idea with a patent application (instead of leaving it as a trade secret, for example). This is a natural expectation and likely accounts for at least part of the treatment effect on patenting output. However, it is unlikely to account for all of it, for two reasons. First, the full treatment effect appeared gradually. If the only consequence of the decisions was an increased incentive to label ideas with patents, that incentive increased discretely at each event date and should not have required years to fully manifest. Second, the previous section showed that R&D spending also increased in response to the greater collateral value of patents. Thus it seems likely that at least part of the effect was driven by increased investment in valuable innovation.

1.4.5. Covenant strictness

The previous sections showed that the increased collateral value of patents, resulting from the strengthening of creditor rights due to the court decisions, eased financing constraints, allowing increased research investment by innovative firms. Moreover, this increased investment translated directly into increased volume, quality, and diversity of research production, as measured by patenting activity. Stronger creditor rights thus encouraged corporate innovation through a financing channel. In this section, I demonstrate that the financing channel involved not only the presence and amount of finance, but also its terms. In particular, I examine the restrictiveness of financial covenants written into the debt contracts of patenting firms.

First, I use Dealscan and an automated search of EDGAR filings to measure the levels of debt covenants wherever possible. I link to Dealscan using the linking file provided in Chava and Roberts (2008). Since these matches end in 2008, I restrict to the years 2000-2008. I focus on the five most common ratio-based covenants in Dealscan (interest coverage ratio, leverage ratio, debt service coverage ratio, fixed charges coverage ratio, and current ratio). Data on these covenants are available for 3,585 firm-months in the sample between the years 2000 and 2008. Of these, 2,151 are from Dealscan, 1,302 are from EDGAR filings, and 132 are present in both.

Next, I use these firms' covenant observations and quarterly Compustat data to construct the covenant strictness measure introduced in Murfin (2012), which reflects the probability that a firm violates any of its covenants over the next quarter. Details are in Section 1.8.3. Then the level of contract strictness is carried forward for each firm until the next time its covenant structure is observed (due to a new loan or amendment), at which point the covenant strictness level is calculated again.

Finally, I consider only strictness observations for companies that remained in Compustat over the subsequent five years. This is done because covenants are often imposed when

firms are deteriorating rapidly, which would limit the interpretation of the results, since firms near bankruptcy likely trade off collateral value against other loan terms differently than do firms farther from distress. (Empirically, the presence and level of a covenant strictness observation in my sample are both strong predictors of exit from Compustat within five years.) Since I consider only the period 2000-2008 in this section due to the end of the Dealscan-Compustat linking file, I am able to observe each sample firm's survival over the next five years with no right-truncation.

Table 12 reports the results of regressions identical to the previous specification (1.3), with covenant strictness as the outcome variable. All columns show that the strengthening of creditor rights had significant, negative effects on covenant strictness. For example, Column (1) demonstrates that average observed strictness decreased by 3% by 2003, and Column (2) shows that the effect was similar for firms in the research-intensive SIC industries. The effects in Columns (1) and (2) disappeared for later years in this specification, but Column (3) demonstrates that this is not the case when restricting to the subsample of firms that are known to have pledged their patents as collateral at some prior time.

The result from Column (3) is summarized in Figure 10, which plots the average observed strictness level for treated and untreated firms separately, retaining the strictness observations only for firms that had previously pledged their patents. The two series tracked each other closely throughout the sample period, except after the first event, when the initial disparity between the two quickly disappeared (that is, treated firms initially received stricter contracts, but within a year of the first event date this was no longer the case). The second event does not appear to have had a marginal effect on covenant strictness; the shortened window makes it impossible to judge whether the third or fourth events had marginal effects.

Column (4) adds firm fixed effects to examine within-firm changes in contract strictness, as was done with the previous outcome variables. By 2004, the ex ante quarterly probability of covenant violation and resulting control rights transfer decreased within-firm by 4.23%.

For a sense of the economic magnitude of this effect, the mean strictness level in my sample is 14.6%, so the reported coefficient translates into a roughly 11% lower annual probability of a covenant violation. Column (5) of Table 12 again shows that the effect is similar when restricting specifically to high-tech firms. In Column (4) as in Column (1), when considering the full sample of patenting firms, the within-firm treatment effect weakened towards the end of the sample, but for the high-tech firms in Column (5) it was sustained. There are too few within-firm changes in the subsample of pledging companies to repeat the analysis of Column (3) with firm fixed effects.

The finding that lenders and borrowers trade off creditor control rights in default against creditor control rights *ex ante* (in the form of loan covenants) is a novel contribution of my study. This finding demonstrates that collateral value can substitute for covenant tightness in secured lending. Nini et al. (2009) and Chava et al. (2013) show that a single covenant violation is associated with significant decreases in both capital expenditures and R&D, so the loosening of covenant structures captured in Table 12 represented significantly increased investment flexibility for the firms in my sample.

1.5. Interpreting the findings

Previous empirical studies of creditor rights and innovation often reach the opposite conclusions to mine. Acharya and Subramanian (2009) and Seifert and Gonenc (2012) find lower rates of patenting and usage of secured debt by innovative industries in countries that have strong creditor rights, or that have recently strengthened creditor rights. Acharya et al. (2011) demonstrate a further negative relationship between creditor rights and firms' willingness to take risks. Vig (2013) shows that firms used less secured debt, and invested more conservatively, in response to a strengthening of secured creditor rights in India.

One explanation for our disparate results may come from the institutional differences between the United States and the countries driving their results. Most notably, India is a country with particularly strong creditor rights but weak enforcement of the law, receiving

scores of 4/4 and 4.17/10 respectively in these categories in the original classification of La Porta et al. (1997). Similarly, the reforming countries that provide the identifying variation in Acharya and Subramanian (2009) have an average creditor-rights score of 2.9 out of 4, but an average rule-of-law score of 8.35, with two of nine countries (Indonesia and Israel) scoring below 5. The United States, by contrast, receives a score of 1 out of 4 for creditor rights – partly due to the strength of its automatic stay in bankruptcy – but receives the maximum rule-of-law score of 10.

Taken together, the results of our studies suggest that strengthened creditor rights are effective for fostering financing and innovation when they are not extremely strong to begin with. Furthermore, since one mechanism for my results is the loosening of restrictive ex ante loan covenants, the strict enforcement of contractual contingencies in the United States may be another critical factor in my findings. This is consistent with evidence from Lerner and Schoar (2005), who show that financial contracts exhibit more state contingencies in countries with stronger legal enforcement, as well as Ponticelli (2013), who demonstrates that the effectiveness of legal reform depends on the effectiveness of its enforcement.

1.6. Conclusions

I have introduced a novel dataset on patent-collateralized debt to document the importance of patent collateral to the financing of innovation. Given this importance, I ask whether stronger creditor rights in default increase or decrease the usage of secured finance and investment in research by patenting firms. The evidence shows that stronger creditor rights resulted in increased access to finance, as well as greater financial flexibility through loosened loan covenants. The mechanism for these effects was an increase in patent pledgeability, which made patents more effective as collateral. The effect of creditor rights in default on contract covenants outside of default represents a previously-undocumented tradeoff between ex post and ex ante control rights. With increased access to credit and increased financial flexibility, firms invested more in research and subsequently produced more patents, and these new patents were highly-cited and spanned a wider range of technology categories.

My findings demonstrate that intangible collateral can have significant economic value. On the other hand, legal uncertainty about the status of patent collateral is a major issue for participants in this market. Clarification of legal issues led to large responses in financing and innovation output for research-intensive firms, suggesting a useful focus for policymakers interested in spurring innovation and growth in the economy. The collateral value of patents should be taken into account in policy debates over the optimal strength of intellectual property rights, since these assets would have no collateral value without those rights. Finally, as innovative firms increasingly gain access to collateralized financing, this could decrease their reliance on sentiment-heavy equities markets to provide financing, potentially providing a route for research financing without reliance on technology bubbles.

1.7. Patents as collateral

Examples

The data include a wide range of companies and financing structures. The common thread in each deal is the importance of patent collateral.

The largest patent collateral portfolio in the sample comes from Eastman Kodak's debtor-in-possession financing with Citigroup in January 2012, a portfolio of 7,741 patents. Nearly as large is the portfolio for a loan made to Xerox in June 2002, in which it pledged 7,442 patents to a syndicate of 13 banks, with Bank One as lead arranger. The detailed documentation relating exclusively to patent collateral testifies to its importance in these deals. However, the most interesting events for my study are those involving borrowers with few pledgeable assets other than patents.

For example, Insite Vision, a developer of optical pharmaceuticals, has issued private placements of patent-collateralized debt several times. One example, from December 2005, raised \$6 million debt financing, with Bank of New York as the collateral agent and Paramount BioCapital as the main investor. As a result, Insite reported \$6.1 million of debt outstanding in 2006Q1, despite having zero sales or revenues, only \$3.9 million in cash or equivalents, and only \$4.7 million in total assets. The all-asset lien included the company's portfolio of 32 pharmaceuticals patents, which were eight years old on average and have received a median of 13 citations and a mean of 18 (compared to a median of 4 and mean of 10 citations for the universe of all patents). A press release from the date of the deal closing announced that the funds would go towards clinical trials and future applications for approval of new products, and financial statements in the subsequent securities registration statement warn that restrictive debt covenants or lack of access to debt financing might interfere with the company's operations.

In another example, Scientific Learning, a developer of educational software, amended an existing secured credit agreement with Comerica Bank in August 2012 to add its portfolio of

81 patents to the collateral pool, where they had previously been explicitly excluded. The company's revenues had been declining, and it had recently violated a financial covenant. Simultaneously with the loan amendment, the lender reduced the commitment amount and tightened the covenant structure. However, the addition of patent collateral provided the lender with recovery value in default and may have prevented it from withdrawing the credit line completely, which would have seriously jeopardized the company's survival. The example demonstrates that collateral, and in particular patent collateral, can substitute for the downside protection achieved through tight covenants or credit rationing.

Variable	Median	Mean	SD	N
Number of patents pledged	8.00	57.40	398.48	742
Deal amount (millions)	98.35	333.20	854.98	742
Firm total assets (millions)	337.81	2405.49	19227.36	687
Deal amount / total assets	0.28	0.34	0.28	687
Maturity (years)	3.92	3.87	2.00	714
All-in drawn spread (bps)	250.00	276.13	139.66	532

Table 1: Sample information on the Dealscan-matched subsample of loans.

	Do not pledge patents	Pledge patents
All industries:	(N = 25032)	(N = 1131)
Tangibility	0.52	0.52
Tangibility (excl. cash)	0.33	0.34
PP&E / Assets	0.26	0.23
High-tech SIC:	(N = 5057)	(N = 504)
Tangibility	0.61	0.57
Tangibility (excl. cash)	0.25	0.30
PP&E / Assets	0.14	0.17

Table 2: Tangibility measures for Compustat-listed firms that do and do not pledge patents. The first is defined as in Berger et al. (1996) and Almeida and Campello (2007): $Tangibility = (0.715 * Receivables + 0.547 * Inventory + 0.535 * PP\&E + Cash) / Assets$. The second excludes cash holdings. The third is net property plant and equipment scaled by total assets. The firm-level means are calculated from annual Compustat since 1990.

Notwithstanding the foregoing, the Collateral shall not include any (1) such property that (a) is nonassignable by its terms without the consent of the licensor thereof or another party (but only to the extent such prohibition on transfer is enforceable under applicable law, including, without limitation, Sections 9406 and 9408 of the Code), (b) the granting of a security interest therein is contrary to applicable law, provided that upon the cessation of any such restriction or prohibition, such property shall automatically become part of the Collateral, or (2) copyrights, patents, trademarks, servicemarks and applications therefor, now owned or hereafter acquired, or any claims for damages by way of any past, present and future infringement of any of the foregoing (collectively, the “Intellectual Property”); provided however, the Collateral shall include all accounts and general intangibles that consist of rights to payment and proceeds from the sale, licensing or disposition of all or any part, or rights in, the foregoing (the “Rights to Payment”). Notwithstanding the foregoing, if a judicial authority (including a U.S. Bankruptcy Court) holds that a security interest in the underlying Intellectual Property is necessary in have a security interest in the Rights to Payment, then the Collateral shall automatically, and effective as of the Closing Date, include the Intellectual Property to the extent necessary to permit perfection of Bank’s security interest in the Rights to Payment.

Excerpt from credit agreement between Scientific Learning and Comerica Bank, February 9, 2012, excluding intellectual property from the collateral portfolio.

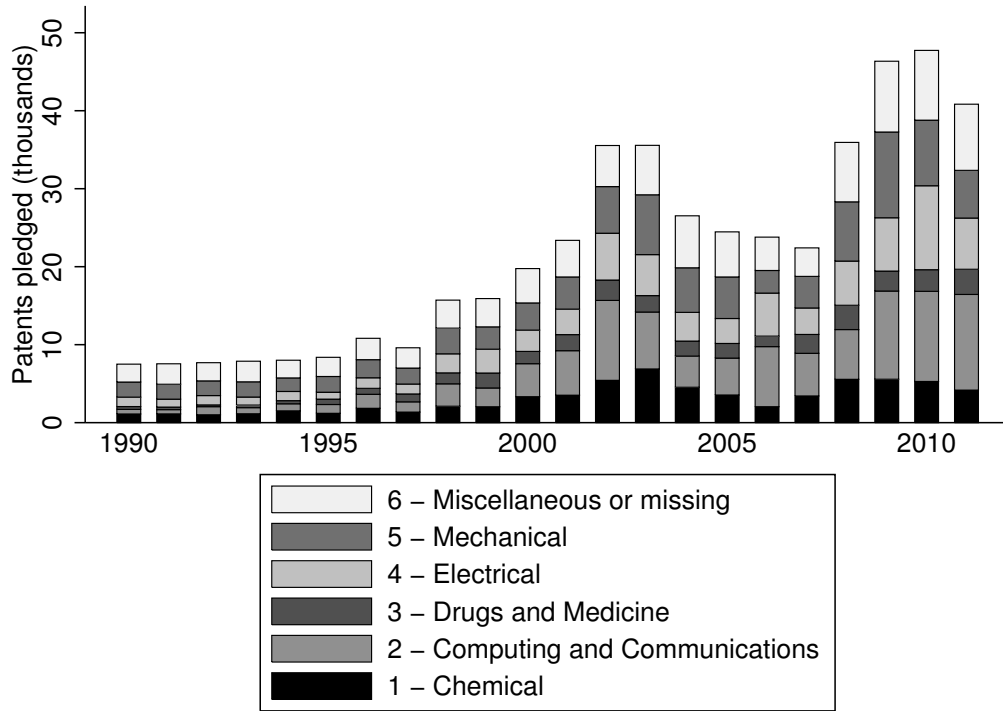
1. The following defined terms are hereby added to Section 1.1 of the Agreement:

“Bookings” means new booked sales as set forth in the forecast provided by Borrower to Bank on August 7, 2012.

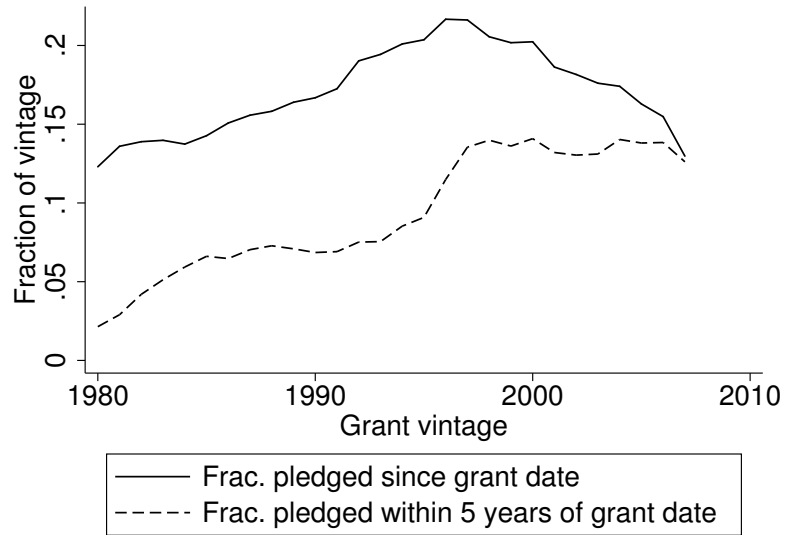
“Intellectual Property Collateral” means all of Borrower’s right, title, and interest in and to the following:

- (a) Copyrights, Trademarks and Patents;
- (b) Any and all trade secrets, and any and all intellectual property rights in computer software and computer software products now or hereafter existing, created, acquired or held;
- (c) Any and all design rights which may be available to Borrower now or hereafter existing, created, acquired or held;
- (d) Any and all claims for damages by way of past, present and future infringement of any of the rights included above, with the right, but not the obligation, to sue for and collect such damages for said use or infringement of the intellectual property rights identified above;
- (e) All licenses or other rights to use any of the Copyrights, Patents or Trademarks, and all license fees and royalties arising from such use to the extent permitted by such license or rights;
- (f) All amendments, renewals and extensions of any of the Copyrights, Trademarks or Patents; and
- (g) All proceeds and products of the foregoing, including without limitation all payments under insurance or any indemnity or warranty payable in respect of any of the foregoing.

Excerpt from an amendment to the same credit agreement, August 14, 2012, adding intellectual property to the collateral pool in response to the borrower’s deterioration.



(a) Number of patents pledged as collateral per year, 1990-2011. The six patenting categories are taken from Hall et al. (2001).



(b) Fraction of patents pledged as collateral, by grant vintage. The solid line shows the fraction of patents in each grant vintage that has since been pledged as collateral. The dotted line shows the fraction of patents that are pledged within five years of their grant date, which is nondecreasing.

Figure 1: Growth in the market for patent-backed loans over time.

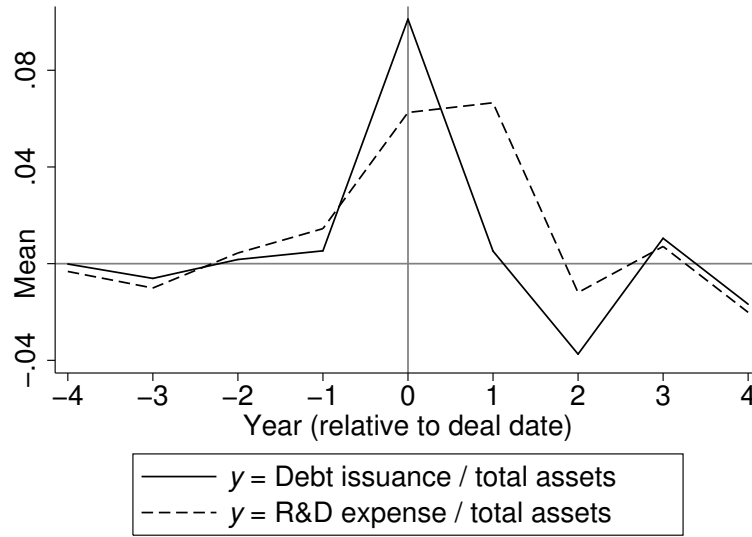
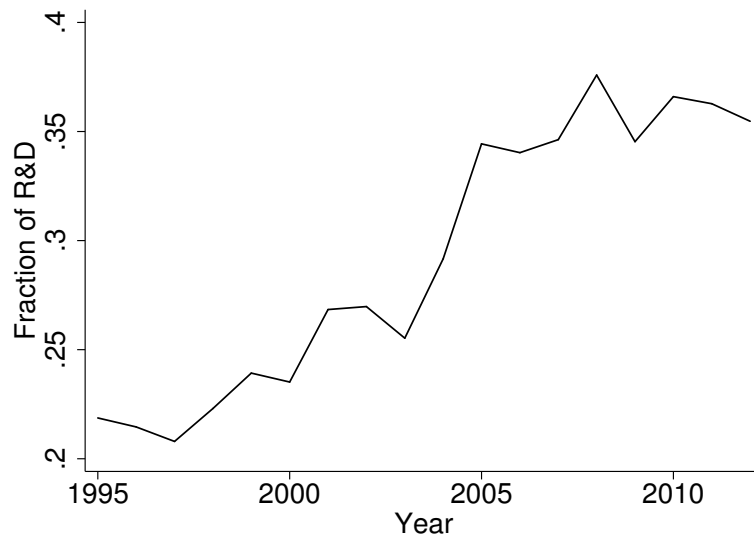
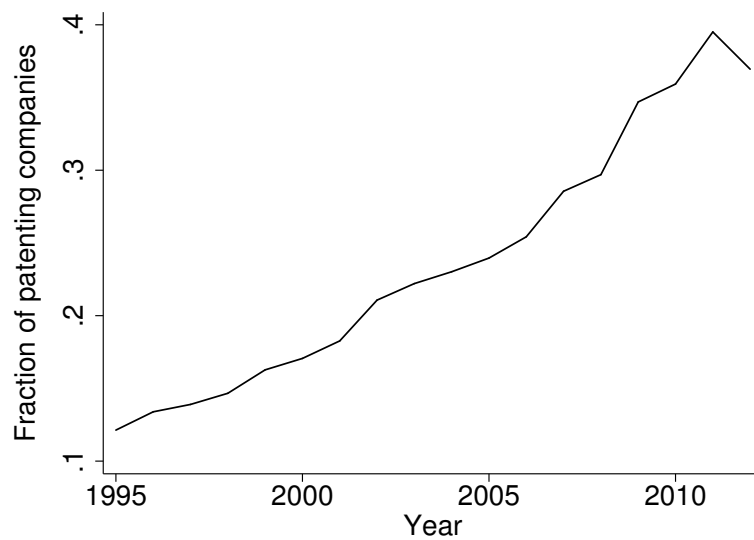


Figure 2: Dynamics of long-term debt issuance and research and development expense around patent-backed financing events. To construct each figure, I obtain annual Compustat data from 1980-2011 for the R&D-intensive industries identified in Brown et al. (2009). I regress the two outcome variables (items DLTIS and XRD respectively) on a firm fixed effect plus distributed lags of time to financing events: $y_{it} = \alpha_i + \sum_{\tau=-4}^4 \beta_{\tau} Pledge_{t-\tau} + \epsilon_{it}$. The figure plots the coefficients β_{τ} from this estimation. R&D-intensive industries are drugs (SIC code 283); office and computing equipment (357); communications equipment (366); electronic components (367); scientific instruments (382); medical instruments (384); and software (737).



(a) Fraction of Compustat R&D performed by companies that have pledged patents as collateral at some point in the past.



(b) Fraction of patenting companies in Compustat (those receiving grants from the USPTO) that have pledged their patents as collateral at some point in the past

Figure 3: Relative importance of firms that borrow against patents to aggregate research investment and output.

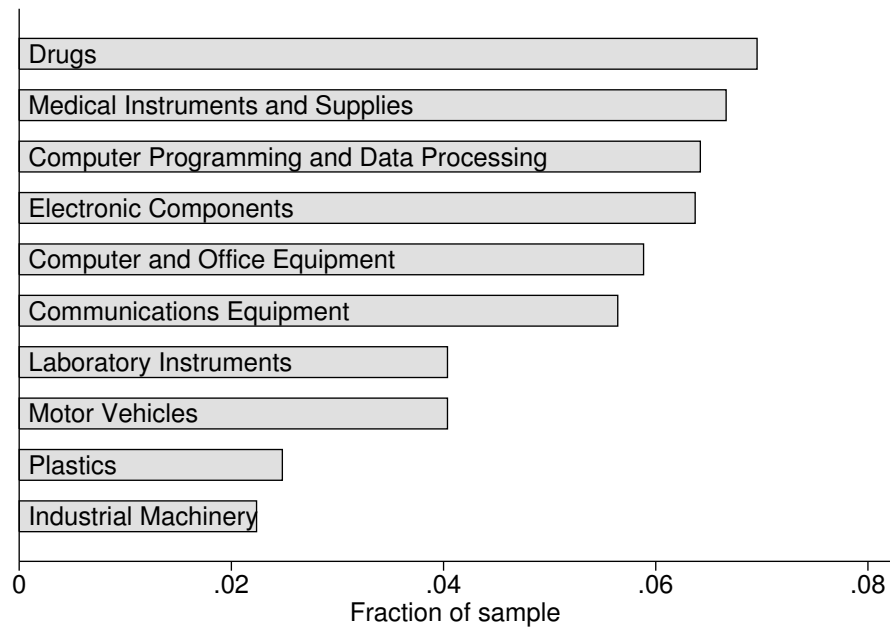


Figure 4: Top ten industries, by 3-digit SIC, of Compustat firms that pledge patents as collateral. Respectively, the codes are 283, 384, 737, 367, 357, 366, 371, 382, 308, 355.

State	Year adopted
Texas	1997
Louisiana	1997
Alabama	2001
Delaware	2002
South Dakota	2003
Virginia	2004
Nevada	2005

Table 3: States and enactment dates of anti-recharacterization laws. Ohio and North Carolina passed similar laws, but restricted their applicability to FDIC-insured bank borrowers, so they are excluded from the empirical analysis.

Case	Decision date
Rhone-Poulenc Agro v DeKalb Genetics Corp.	March 26, 2002
Pasteurized Eggs Corporation v Bon Dente Joint Venture	May 30, 2003
Braunstein v Gateway Management Services	May 15, 2007
Sky Technologies LLC v SAP AG and SAP America	August 20, 2009

Table 4: Court decisions used in my identification strategy.

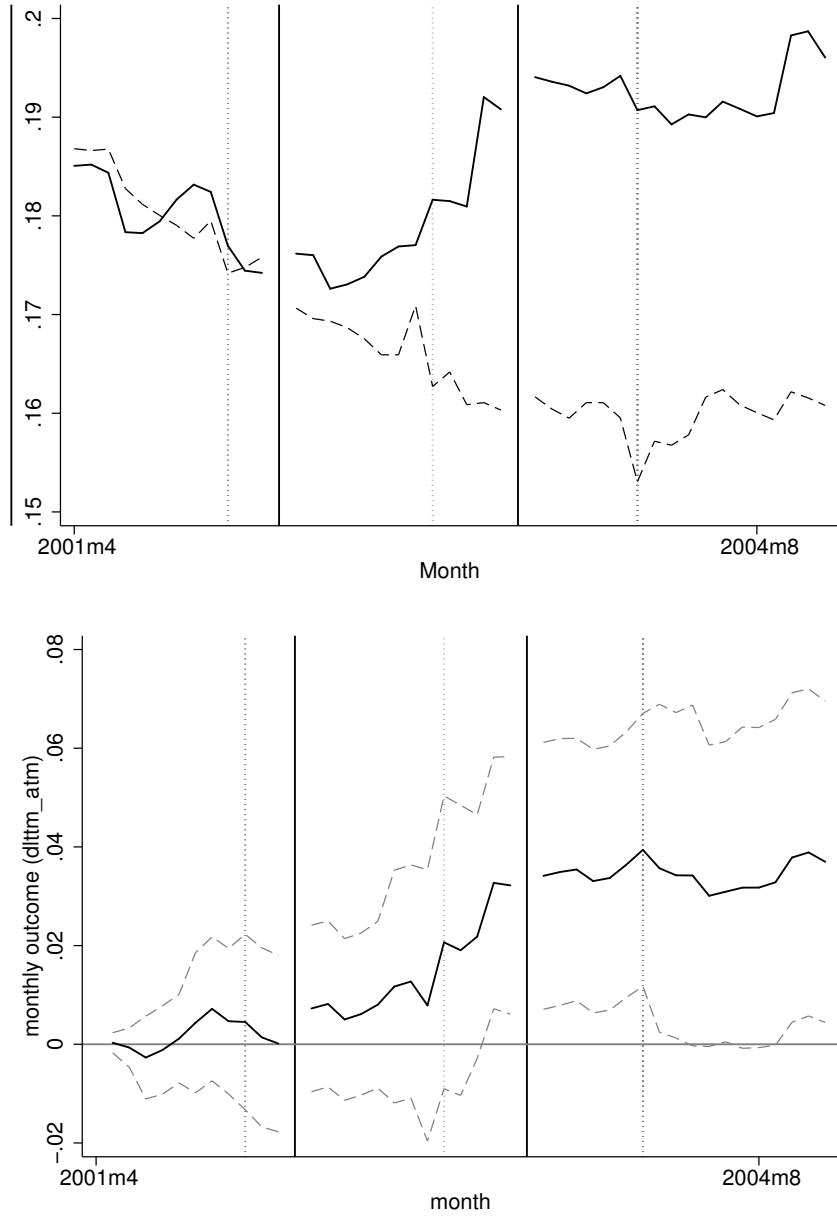


Figure 5: Evolution of debt financing around the first two event dates. The outcome variable in both panels is the level of long-term debt scaled by total assets, measured at a monthly frequency. Panel (a) plots sample means separately for treated firms (solid) and untreated firms (dashed), as described in Section 1.2. Panel (b) regresses the outcome variable on a saturated model with a treatment indicator and monthly dummies, and plots the coefficients on the treatment-month interactions (equivalent to difference-in-difference estimates for each month from Panel (a) relative to the first month), along with 95% confidence intervals calculated from standard errors clustered by state of incorporation.

	Untreated	Treated	$p - val$
Assets - Total	2903.86	2792.79	0.87
Sales/Turnover (Net)	2364.90	2077.13	0.51
Property, Plant and Equipment - Total (Net)	975.06	843.45	0.53
Long-Term Debt - Total	651.94	682.53	0.88
Total Debt	820.36	871.88	0.86
Research and Development Expense	78.81	82.46	0.86
Capital Expenditures	150.17	159.12	0.84
Selling, General and Administrative Expense	446.76	338.84	0.12
Long-Term Debt / Total Assets	0.18	0.18	0.77
Total Debt / Total Assets	0.26	0.27	0.58
R&D Expense / Total Assets	0.11	0.14	0.03
Patents produced in last 10 years	131.53	104.67	0.40
Number of firms	646	1317	

Table 5: Comparison of treated and untreated companies included in the natural experiment. Treated companies are those incorporated in states with pro-creditor laws. Financial data are from annual Compustat, calendar year 2001. The first two columns show subsample means. The last column shows the p-value from a two-sided t-test of the difference in means.

1.8. Data appendix

1.8.1. Details about patent collateral data

The Assignments dataset provides a patent number and date for each pledge of patents as collateral, as well as names of the secured party and the pledging firm. I match the latter to NBER firm identifiers, then use the NBER linking file to match these identifiers to Compustat, carrying forward the most recent set of matches to years since 2006.

Assigning the pledging companies to NBER identifiers is a complex task, as the name of the pledging company is often different from that of the original patenting company due to M&A activity, name changes, holding patents in subsidiaries or holding companies, or sales or other transfers of the patents. My approach is as follows: The Assignments data includes the entire chain of title to each patent, from its initial grant to the inventor, then its assignment to the patenting company, and subsequently through any future assignments and collateral pledges. At each point in this chain, I attempt to match the name of the

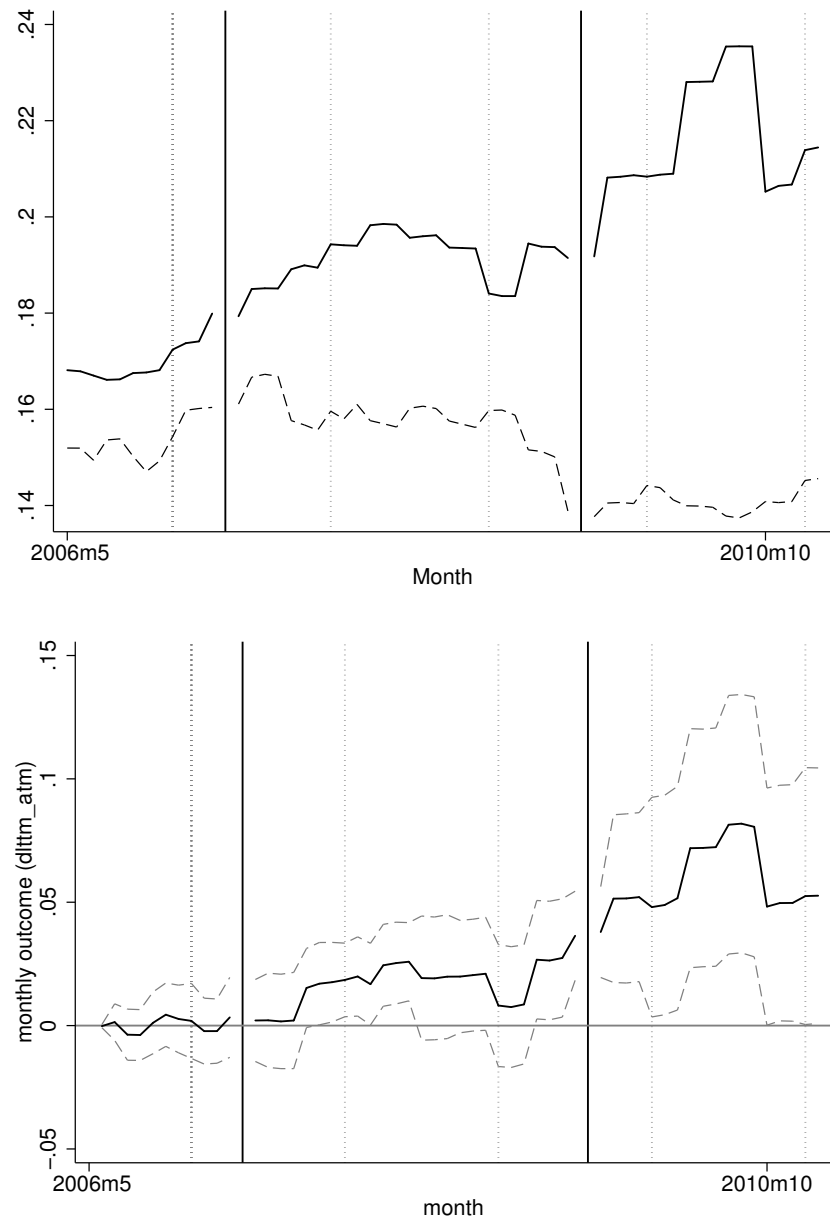


Figure 6: Evolution of debt financing around the third and fourth event dates. The outcome variable in both panels is the level of long-term debt scaled by total assets, measured at a monthly frequency. Panel (a) plots sample means separately for treated firms (solid) and untreated firms (dashed), as described in Section 1.2. Panel (b) regresses the outcome variable on a saturated model with a treatment indicator and monthly dummies, and plots the coefficients on the treatment-month interactions (equivalent to difference-in-difference estimates for each month from Panel (a) relative to the first month), along with 95% confidence intervals calculated from standard errors clustered by state of incorporation.

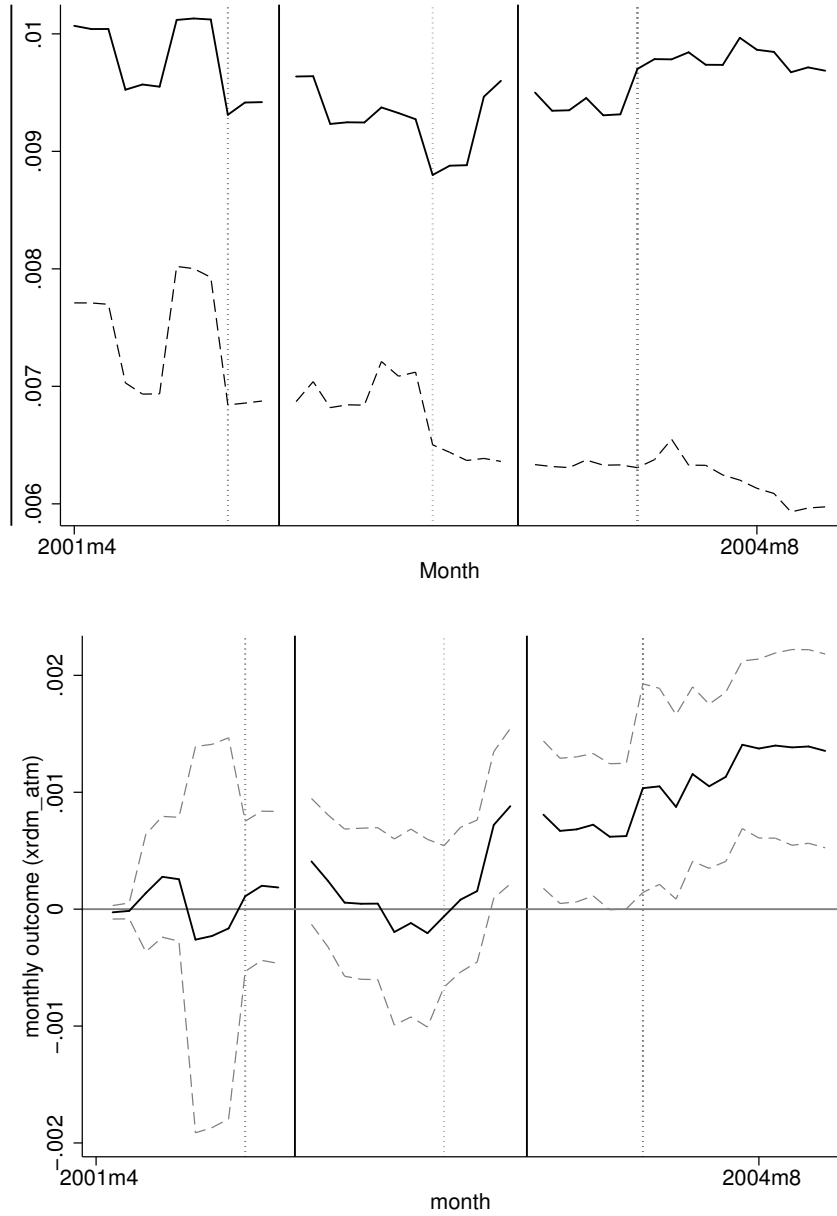


Figure 7: Evolution of R&D investment around the first two event dates. The outcome variable in both panels is monthly R&D expense scaled by total assets. Panel (a) plots sample means separately for treated firms (solid) and untreated firms (dashed), as described in Section 1.2. Panel (b) regresses the outcome variable on a saturated model with a treatment indicator and monthly dummies, and plots the coefficients on the treatment-month interactions (equivalent to difference-in-difference estimates for each month from Panel (a) relative to the first month), along with 95% confidence intervals calculated from standard errors clustered by state of incorporation.

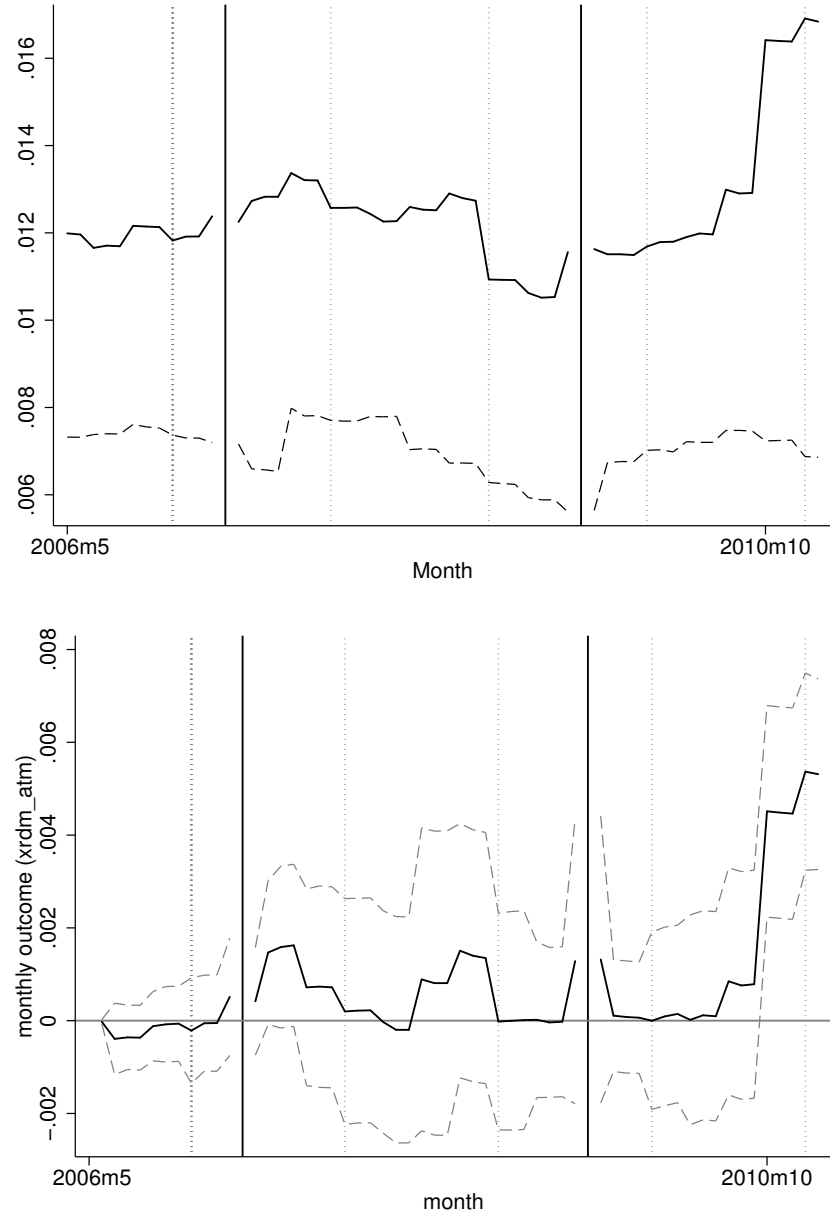
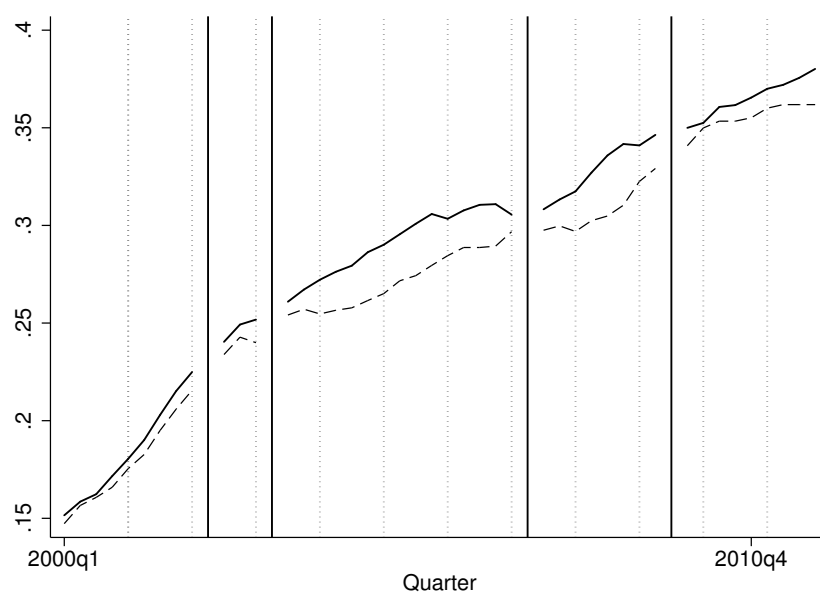
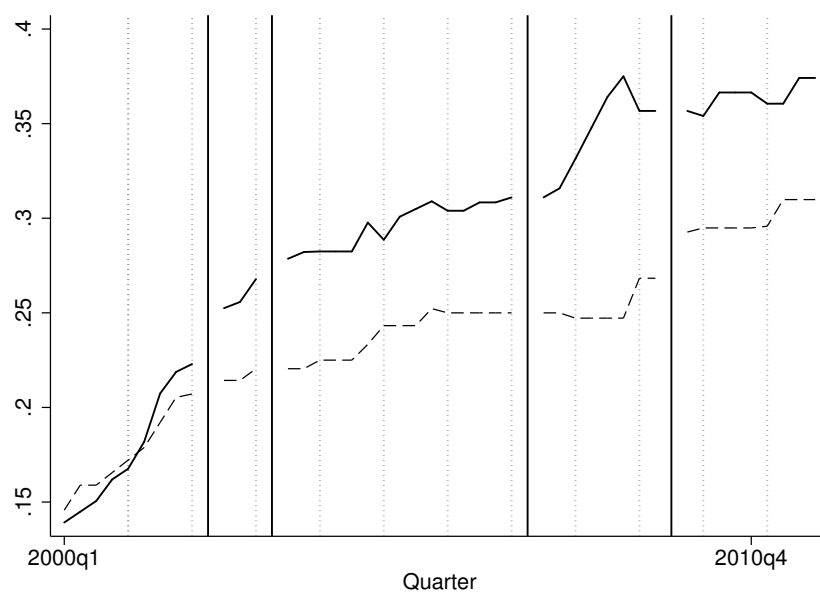


Figure 8: Evolution of R&D investment around the third and fourth event dates. The outcome variable in both panels is monthly R&D expense scaled by total assets (see the text for details of the calculations). Panel (a) plots sample means separately for treated firms (solid) and untreated firms (dashed), as described in Section 1.2. Panel (b) regresses the outcome variable on a saturated model with a treatment indicator and monthly dummies, and plots the coefficients on the treatment-month interactions (equivalent to difference-in-difference estimates for each month from Panel (a) relative to the first month), along with 95% confidence intervals calculated from standard errors clustered by state of incorporation.

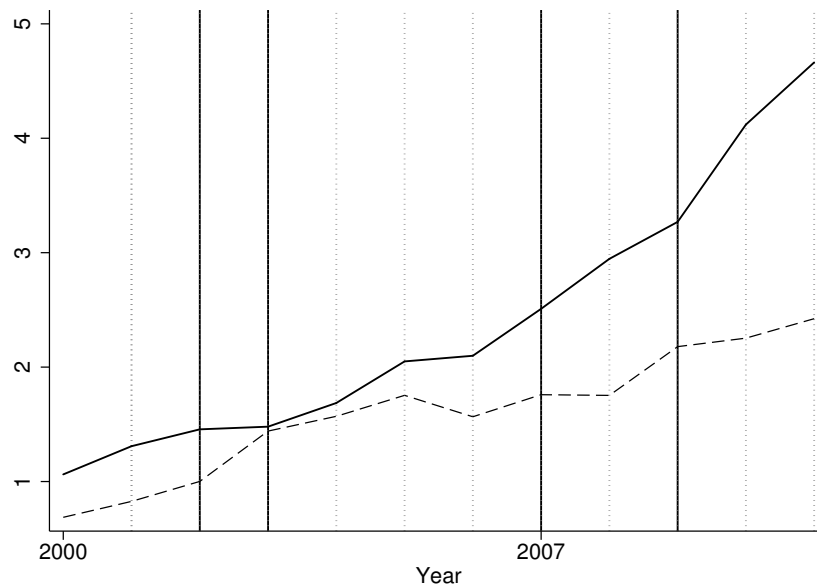


(a) Sample means, separately for treated firms (solid) and untreated firms (dashed).

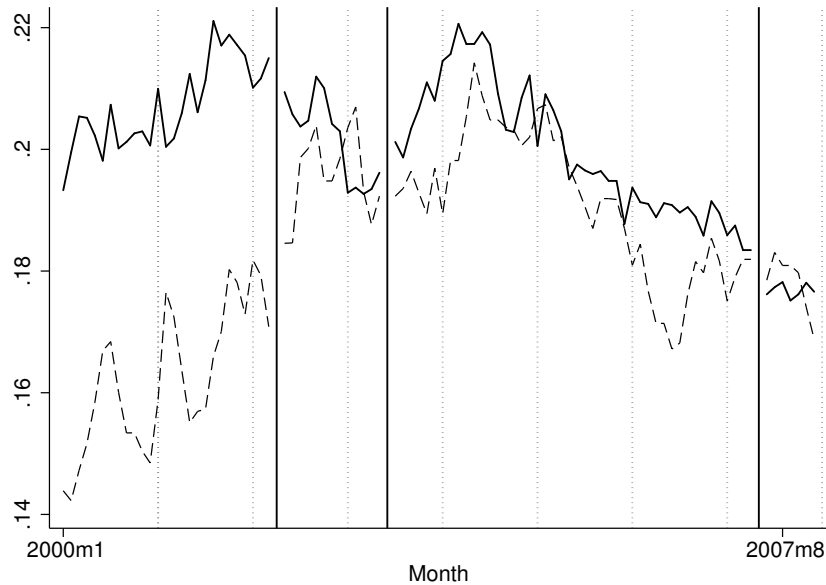


(b) Sample means, separately for treated firms (solid) and untreated firms (dashed). The sample is restricted to small firms (total assets less than \$100m as of April 2001) in R&D intensive SIC industries.

Figure 9: Proportion of sample firms that are observed to have pledged patents as collateral at any point in the past.



(a) Average annual rescaled patenting intensity for treated firms (solid) and untreated firms (dashed). Patenting intensity is the number of patent applications filed by a firm divided by the number of grants that firm has received over the previous ten years. Rescaled patenting intensity multiplies the number of patent applications by the inflation factor mentioned in the text, which is introduced to deal with right-truncation in the firm-level patenting data. This inflation factor is the number of US corporate patent applications reported by the USPTO in a given year divided by the number of those application that have been assigned to Compustat identifiers.



(b) Average strictness of debt contract covenant structures for firms that have ever pledged patents as collateral, separately for treated firms (solid) and untreated firms (dashed). The strictness measure follows Murfin (2012). See the text for details of the calculation.

Figure 10: Patenting intensity and contract strictness for treated and untreated firms.

	(1)	(2)	(3)	(4)	(5)	(6)
Treated	-0.000134 (0.0173)					
After first event	-0.0141** (0.00652)	-0.0128** (0.00576)	-0.0430** (0.0161)	-0.00845 (0.0112)	-0.0177* (0.0102)	-0.0182 (0.0172)
After second event	-0.0206* (0.0117)	-0.0163 (0.0105)	-0.0478*** (0.0157)	-0.0137 (0.0191)	-0.0151 (0.0139)	-0.0262 (0.0230)
Treated, after first event	0.0124* (0.00717)	0.0116* (0.00627)	0.0339** (0.0162)	0.0224 (0.0142)	0.0219* (0.0115)	0.0375* (0.0213)
Treated, after second event	0.0328*** (0.0117)	0.0250** (0.0106)	0.0450*** (0.0161)	0.0401** (0.0195)	0.0279* (0.0140)	0.0359 (0.0235)
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Sample	All	All	Have pledged	AT <100.00	High-R&D	High-R&D; AT <100.00
Obs.	77664	77664	14163	27396	39332	19175
Within R^2	0.00144	0.00139	0.00802	0.00216	0.00150	0.00211

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Regression analysis of debt financing around the first two event dates. The coefficients are from Specification (1.2). The dependent variable is long-term debt scaled by total assets. The firm-month panel extends from April 2001 to February 2005 and includes US firms that have produced at least one patent in the ten years prior. “Have pledged” is the subset of firms that are observed to have pledged their patents as collateral at some point before April 2001. “Small” is the subset of firms with less than \$100m in total assets at April 2001. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). Standard errors in each column are clustered by state of incorporation.

	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.0164 (0.0113)					
After third event	0.00469 (0.00544)	0.00731 (0.00464)	-0.0157 (0.00924)	0.0161 (0.0146)	0.0144 (0.0102)	0.0328* (0.0191)
After fourth event	-0.0128* (0.00741)	-0.00739 (0.00701)	-0.0257** (0.0113)	-0.0000687 (0.0150)	-0.0119 (0.0112)	0.00566 (0.00955)
Treated, after third event	0.0162*** (0.00549)	0.0175*** (0.00535)	0.0399*** (0.00949)	0.0383** (0.0155)	0.0301** (0.0116)	0.0431** (0.0208)
Treated, after fourth event	0.0571** (0.0216)	0.0553** (0.0237)	0.0633*** (0.0115)	0.142** (0.0621)	0.108** (0.0462)	0.202** (0.0916)
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Sample	All	All	Have pledged	AT <100.00	High-R&D	High-R&D; AT <100.00
Obs.	95301	95301	22998	31541	49867	22548
Within R^2	0.00216	0.00156	0.00245	0.00481	0.00360	0.00775

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Regression analysis of debt financing around the third and fourth event dates. The coefficients are from Specification (1.2), where the dependent variable is long-term debt scaled by total assets. The firm-month panel covers the same time period as in Figure 6 above (May 2006 to February 2011). “Have pledged” is the subset of firms that are observed to have pledged their patents as collateral at some point before May 2006. “Small” is the subset of firms with less than \$100m in total assets at May 2006. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). Standard errors in each column are clustered by state of incorporation.

	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.00246** (0.00122)					
After first event	-0.000644** (0.000244)	-0.000500* (0.000280)	0.000170 (0.000295)	-0.00100 (0.000808)	-0.00104 (0.000927)	-0.00143 (0.00175)
After second event	-0.00120*** (0.000387)	-0.000966** (0.000453)	-0.00109* (0.000619)	-0.00266** (0.00122)	-0.00189* (0.000930)	-0.00346** (0.00167)
Treated, after first event	0.000102 (0.000245)	-0.00000604 (0.000282)	-0.0000198 (0.000298)	0.000465 (0.000812)	0.000271 (0.000929)	0.000991 (0.00176)
Treated, after second event	0.000967** (0.000390)	0.000704 (0.000456)	0.00127* (0.000625)	0.00253** (0.00122)	0.00134 (0.000936)	0.00315* (0.00167)
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Sample	All	All	Have pledged	AT <100.00	High-R&D	High-R&D; AT <100.00
Obs.	77664	77664	14163	27396	39332	19175
Within R^2	0.00608	0.00101	0.00331	0.00221	0.00185	0.00282

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Regression analysis of R&D investment around the first two event dates. The coefficients are from Specification (1.2), where the dependent variable is monthly R&D expense scaled by total assets (see the text for details of the calculation). The firm-month panel covers the same time period as in Figure 7 above (April 2001 to February 2005). “Have pledged” is the subset of firms that are observed to have pledged their patents as collateral at some point before April 2001. “Small” is the subset of firms with less than \$100m in total assets at April 2001. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). Standard errors in each column are clustered by state of incorporation.

	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.00465*** (0.00136)					
After third event	-0.000444 (0.000586)	-0.000505 (0.000589)	-0.00129 (0.000903)	-0.00156 (0.00177)	-0.000293 (0.000727)	-0.000766 (0.00141)
After fourth event	-0.000509 (0.000942)	-0.000339 (0.000925)	-0.00219 (0.00134)	-0.00122 (0.00324)	-0.000967 (0.000945)	-0.00265 (0.00201)
Treated, after third event	0.000713 (0.000824)	0.000667 (0.000754)	-0.000110 (0.000905)	0.00281 (0.00216)	-0.000419 (0.00138)	0.0000883 (0.00295)
Treated, after fourth event	0.00157 (0.00103)	0.00139 (0.000938)	0.00657*** (0.00135)	0.00500 (0.00324)	0.00253** (0.00107)	0.00695*** (0.00216)
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Sample	All	All	Have pledged	AT <100.00	High-R&D	High-R&D; AT <100.00
Obs.	95301	95301	22998	31541	49867	22548
Within R^2	0.00326	0.000121	0.00139	0.000425	0.000379	0.000844

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Regression analysis of R&D investment around the third and fourth event dates. The coefficients are from Specification (1.2), where the dependent variable is monthly R&D expense scaled by total assets (see the text for details of the calculation). The firm-month panel covers the same time period as in Figure 8 above (May 2006 to February 2011). “Have pledged” is the subset of firms that are observed to have pledged their patents as collateral at some point before May 2006. “Small” is the subset of firms with less than \$100m in total assets at May 2006. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). Standard errors in each column are clustered by state of incorporation.

	(1) Pledged	(2) Pledged	(3) Pledged	(4) Pledged	(5) Pledged	(6) Pledged
Treated	0.00343	-0.00784				
Treated, 2001	0.00398	0.0154	0.00333	0.00376	0.0119	0.0158
Treated, 2002	0.00309	0.0360	-0.00406	0.00544	0.0113	0.0340
Treated, 2003	0.00633	0.0618*	-0.00202	0.0176	0.0126	0.0545**
Treated, 2004	0.0175	0.0654*	0.00736	0.0261	0.0207	0.0628**
Treated, 2005	0.0220	0.0636*	0.00881	0.0301	0.0244	0.0725***
Treated, 2006	0.0169	0.0629*	0.00795	0.0316	0.0290	0.0761***
Treated, 2007	0.00721	0.0692**	0.00720	0.0385*	0.0258	0.0856***
Treated, 2008	0.0234	0.114***	0.0208	0.0742***	0.0337	0.116***
Treated, 2009	0.0116	0.0881**	0.0206	0.0833***	0.0288	0.131***
Treated, 2010	0.00368	0.0768*	0.0140	0.0821***	0.0268	0.124***
Treated, 2011	0.00958	0.0665	0.0245	0.0753***	0.0356	0.111***
Firm FE	No	No	Yes	Yes	Yes	Yes
Sample	All	High-R&D; AT <100.00	All	AT <100.00	High-R&D	High-R&D; AT <100.00
Obs.	212340	50637	212340	71577	106233	50637
Within R^2	0.0198	0.0217	0.108	0.107	0.0985	0.109

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Regression analysis of the proportion of firms having pledged patents as collateral. The coefficients are from Specification (1.3), where the outcome variable is an indicator for whether a firm has been observed pledging its patents as collateral at any point in the past. “Small” is the subset of firms with less than \$100m in total assets at April 2001. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). Standard errors are clustered by state of incorporation.

	(1)	(2)	(3)	(4)	(5)	(6)
	Apps/Patents	Apps/Patents	Inf. Apps/Patents	Inf. Apps/Patents	Categories	Citations
Treated, 2001	-0.00273	-0.00266	-0.00418	0.00438	-0.0555	0.772
Treated, 2002	-0.00511	-0.00685	-0.0118	-0.000510	0.0542	1.993***
Treated, 2003	-0.00954***	-0.00784**	-0.0121	-0.0337	-0.0245	0.919
Treated, 2004	-0.00580**	-0.00586**	-0.00462	-0.0283	0.0380	-0.131
Treated, 2005	0.00224	0.00691	0.0381***	-0.0105	0.00342	0.373
Treated, 2006	0.00887	0.0166**	0.0899***	0.00444	0.105	1.217
Treated, 2007	0.0144**	0.0215**	0.136***	0.0247	0.290***	2.350
Treated, 2008	0.0248***	0.0370***	0.262***	0.0584**	0.214***	4.790
Treated, 2009			-0.0195	0.0437		3.425
Treated, 2010			0.0997***	0.110***		6.273
Treated, 2011			0.212***	0.134***		7.545
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Small	High-R&D, Small	High-R&D, Small	All	High-R&D, Small	High-R&D, Small
Obs.	59793	42117	50637	212340	3981	4267
R^2	0.00137	0.00169	0.00248	0.00190	0.0114	0.0862

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Regression analysis of the patenting output of treated companies. The coefficients are from Specification (1.3), where the outcome variable is listed at the top of each column. “Small” is the subset of firms with less than \$100m in total assets at April 2001. “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). with \$100m or less of total assets as of the beginning of the event window (April 2001). “Inflated applications” are firm-level monthly counts of new patent applications filed with the Patent Office, multiplied by the ratio of aggregate corporate patenting to observed corporate patenting in that year. Standard errors are clustered by state of incorporation.

	(1)	(2)	(3)	(4)	(5)
	Strictness	Strictness	Strictness	Strictness	Strictness
Treated	0.0225	0.0339*	0.0478		
Treated, 2001	-0.000268	-0.0132*	-0.00338	0.000817	-0.0175**
Treated, 2002	-0.0178	-0.0288*	-0.0283	-0.0203**	-0.0264
Treated, 2003	-0.0318*	-0.0293**	-0.0427	-0.0310***	-0.0286*
Treated, 2004	-0.0333**	-0.0352**	-0.0377	-0.0438***	-0.0419**
Treated, 2005	-0.0256*	-0.0190	-0.0453*	-0.0375***	-0.0386**
Treated, 2006	-0.0176	-0.0248	-0.0347	-0.0294***	-0.0510**
Treated, 2007	-0.00755	-0.0100	-0.0467*	-0.0219*	-0.0326**
Firm FE	No	No	No	Yes	Yes
Sample	All	High-R&D	Have pledged	All	High-R&D
Obs.	49598	15925	15124	49598	15925
Within R^2	0.00461	0.00644	0.00522	0.0172	0.0212

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Regression analysis of loan covenant strictness. The coefficients are from Specification (1.3), where the outcome variable is the measure of contract covenant strictness (see the text for details of the calculation). “High-R&D” is the subset of firms in the seven R&D-intensive SIC codes listed in Section 1.2 and taken from Brown et al. (2009). “Have pledged” is an indicator for whether the firm has pledged its patents as collateral at any point prior to the current quarter. Standard errors are clustered by state of incorporation.

	Untreated	Treated	$p - val$
Assets - Total	3824.57	3663.85	0.83
Sales/Turnover (Net)	3654.33	3114.76	0.49
Property, Plant and Equipment - Total (Net)	1251.89	1147.94	0.73
Long-Term Debt - Total	633.97	760.45	0.48
Total Debt	753.14	940.38	0.45
Research and Development Expense	117.24	104.81	0.65
Capital Expenditures	182.67	190.13	0.88
Selling, General and Administrative Expense	647.03	485.02	0.16
Long-Term Debt / Total Assets	0.14	0.16	0.08
Total Debt / Total Assets	0.53	0.70	0.67
R&D Expense / Total Assets	0.09	0.19	0.00
Patents produced in last 10 years	182.07	140.66	0.39
Number of firms	563	1413	

Table 13: Comparison of treated and untreated companies included in the natural experiment for the windows centered on events 3 and 4 (compare with Table 5). Treated companies are those incorporated in states with pro-creditor laws. Financial data are from annual Compustat, calendar year 2006. The first two columns show subsample means. The last column shows the p-value from a two-sided t-test of the difference in means. The only significant differences between the treated and untreated samples are in terms of long-term debt financing and R&D expense scaled by total assets, which were also the variables that demonstrated strong treatment effects in response to the first pair of events.

current or new owner with a name listed in the NBER data. My name matching algorithm is described in Section 1.8.2 below. Having performed this matching, for any pledge events that could not be matched manually, I refer to the most recent assignment or grant in that patent's chain and fill in the acquiring company from that event, if it was matched. If the previous assignment was not matched, I leave the identifier missing.

Even with this approach, problems can arise when a small company includes in its collateral portfolio limited rights to a patent that it is merely licensing from a larger corporation. For example, in August 2002, Matrics Inc pledged nine patents that it owned to Comerica Bank, but also included patent number 6198937, owned by Motorola. To avoid coding Motorola as a patent pledger in this case, I require a firm to pledge at least 2% of its existing patent stock in order to record a pledge event (given that patents are usually pledged in bundles and most often as entire portfolios). This procedure leaves me with 2,208 firm-events of Compustat firms pledging patents as collateral since 1990. These observations exhibit an accuracy of around 95% in repeated hand-checking of samples, but at the cost of screening out over half of firm-months that appear to pledge patents, resulting in conservative estimates of the prevalence of patenting activity.

1.8.2. Firm-level patenting data post-2006

The Google Patents data contain both granted patents and pending applications, but the company producing the patent cannot be observed until the patent is granted, at which point the inventor transfers it to the corporation. Thus, I restrict to patents that have actually been granted by the Patent Office, and I manually match the company name to a list of all NBER firm identifiers for US-headquartered companies that have been assigned at least five patents as of year-end 2006 (this restriction is necessary to keep the processing time manageable).

To match the company names, I take the first 30 characters of each name, eliminate some of the most common corporate words, and calculate a distance between two company names

by sequentially calculating the usual Levenshtein distance between each word in the two names, dividing each distance by the maximum length of the two words (so that the penalty is per fraction of letters wrong, not number) and then dividing again by the square of the word's position in the company name (so that it is relatively more important to match the first few words of a company's name).

I am able to match 59% of domestic corporate patents granted since 2007 with firm identifiers (for comparison, 76% of domestic corporate patents granted prior to 2007 are assigned firm identifiers in the NBER data). Extensive hand checking has turned up no mistaken matches. Figure 11 displays the fraction of patents reported by the USPTO that are accounted for in the NBER and in my data, dated by grant year in Panel (a) and by application year in Panel (b).

The data also include application dates, allowing me to time the applications by quarter, where most patent datasets contain only the application year. Finally, citation pairs are also available for all granted patents through the present, allowing me to construct the citation counts received by a patent within any horizon of its grant date.

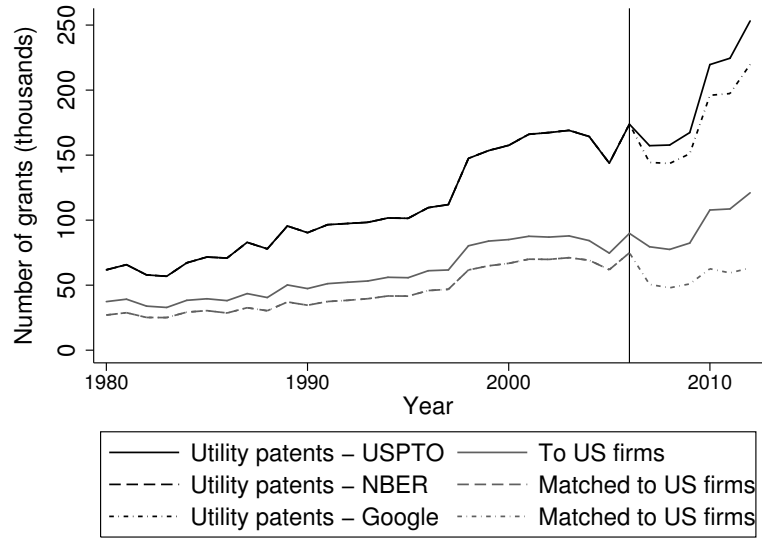
1.8.3. Covenant strictness

The covenants used in my analysis are: leverage ratio, fixed charges coverage ratio, current ratio, interest coverage ratio, debt service coverage ratio, debt ratio.

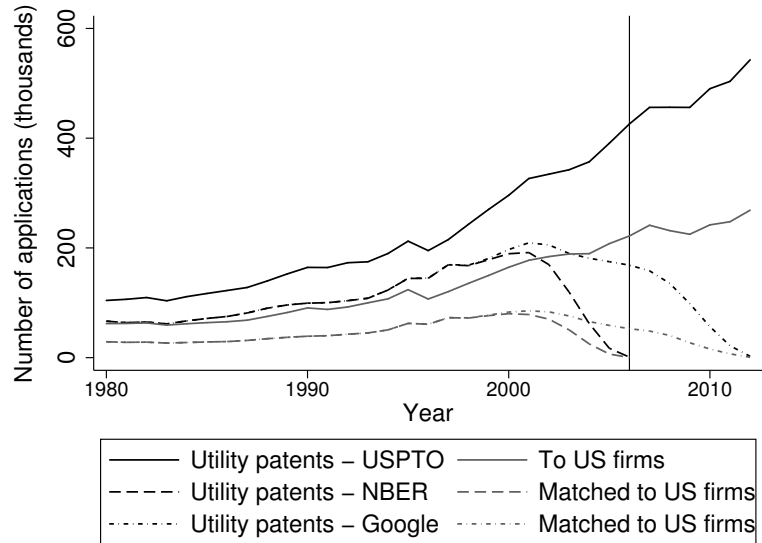
1.8.3.1 Performance measure definitions

I follow the definitions presented in Murfin (2012) for all variables. A few additional definitions are necessary:

Debt service: the rolling four-quarter sum of quarterly interest expense and quarterly debt reduction (the first difference of *dltry*, or zero if this value is negative). Definition taken from the LSTA Handbook of Loan Syndications and Trading, page 304.



(a) Timed by grant year.



(b) Timed by application year.

Figure 11: Summary of aggregate and firm-matched patenting data. The solid black lines are the total number of utility patent grants or applications reported by the USPTO for that year (grants in Panel (a), applications in Panel (b)). The lighter solid line is the number of those grants or applications that the USPTO reports are from US companies. The dashed black line is the total number recorded in the NBER data, and the lighter dashed line is the number of those that are assigned firm identifiers, both of which end with patents granted in 2006. Finally, the dark dotted line is the total number of patents recorded in my combined dataset from the NBER and Google Patents, and the lighter dotted line is the number of those that are assigned to firm identifiers.

Debt service coverage ratio: Ratio of rolling four-quarter sum of EBITDA to debt service. Definition taken from LSTA Handbook page 303.

Leverage ratio: the ratio of total debt to total debt plus net worth. Taken from the most common definition encountered in a sample of loan documents.

Debt ratio: Total debt over the rolling four-quarter sum of EBITDA. Definition taken from LSTA Handbook page 309.

1.8.3.2 Leverage and debt ratio covenant definitions

The definitions of leverage ratio and debt ratio can vary across institutional settings. Checking observations individually suggests that Dealscan codes these two according to the content of the covenant, not its label, and maintains the definitions provided by the LSTA (in which a leverage ratio is the ratio of total liabilities to tangible net worth, while a debt ratio is the ratio of debt to the rolling sum of EBITDA). Meanwhile, extensive reading through the loan documents in the sample indicates that, in over 90% of observations, leverage ratio and debt ratio both refer to the LSTA's definition of a debt ratio. My approach is to take the Dealscan values to be consistent with the LSTA definitions, and then to code all observations of either covenant in the EDGAR data as an LSTA debt ratio (dropping 21 observations from the EDGAR data that list both a leverage and a debt ratio).

1.8.3.3 Other notes

The results reported in Murfin (2012) calculate the covariance matrices of changes in covenant levels separately for each year and for 1-digit SIC code. However, he notes that results are little affected if the industries are pooled instead. For simplicity and to maximize the number of observations used to calculate each covariance matrix, I take the latter approach.

1.8.4. Compustat calculations

- **Total assets** = rolling eight-quarter average of **atq**
- **Long-term debt** = **dlttq**
- **R&D expense** = **xrdq** + **rdipq**
 - For firms that report R&D only at year-end, I divide year-end R&D evenly over all four quarters.
 - Variable **rdipq** is coded in Compustat as a negative number, so adding it to **xrdq** removes the acquired in-process component of R&D expenditure.
 - Additional observations on acquired in-process R&D are merged from annual Compustat and subtracted from the quarter with the largest R&D expense in the firm's fiscal year.

1.9. Delaware Asset-Backed Securities Facilitation Act

§ 2701A Title.

This chapter may be referred to as the “Asset-Backed Securities Facilitation Act.”

§ 2702A Intent.

It is intended by the General Assembly that the term “securitization transaction” shall be construed broadly.

§ 2703A Securitization transaction.

(a) Notwithstanding any other provision of law, including, but not limited to, §9-506 of this title, “Debtor’s right to redeem collateral,” as said section existed prior to July 1, 2001, and §9-623 of the title, “Right to redeem collateral,” which became effective July 1, 2001, to the extent set forth in the transaction documents relating to a securitization transaction:

- (1) Any property, assets or rights purported to be transferred, in whole or in part, in the securitization transaction shall be deemed to no longer be the property, assets or rights of the transferor;
- (2) A transferor in the securitization transaction, its creditors or, in any insolvency proceeding with respect to the transferor or the transferor’s property, a bankruptcy trustee, receiver, debtor, debtor in possession or similar person, to the extent the issue is governed by Delaware law, shall have no rights, legal or equitable, whatsoever to reacquire, reclaim, recover, repudiate, disaffirm, redeem or recharacterize as property of the transferor any property, assets or rights purported to be transferred, in whole or in part, by the transferor; and

- (3) In the event of a bankruptcy, receivership or other insolvency proceeding with respect to the transferor or the transferor's property, to the extent the issue is governed by Delaware law, such property, assets and rights shall not be deemed to be part of the transferor's property, assets, rights or estate.
- (b) Nothing contained in this chapter shall be deemed to require any securitization transaction to be treated as a sale for federal or state tax purposes or to preclude the treatment of any securitization transaction as debt for federal or state tax purposes or to change any applicable laws relating to the perfection and priority of security or ownership interests of persons other than the transferor, hypothetical lien creditor or, in the event of a bankruptcy, receivership or other insolvency proceeding with respect to the transferor or its property, a bankruptcy trustee, receiver, debtor, debtor in possession or similar person.

It is not the purpose of this chapter to change the tax treatment of securitizations that take place pursuant to this chapter.

CHAPTER 2 : Financing Through Asset Sales

Alex Edmans and William Mann

Abstract

Most research on firm financing studies the choice between debt and equity. We model an alternative source – non-core asset sales – and identify three new factors that drive a firm’s choice between selling assets and equity. First, equity investors own a claim to the cash raised. Since cash is certain, this mitigates the information asymmetry of equity (the “certainty effect”). In contrast to Myers and Majluf (1984), even if non-core assets exhibit less information asymmetry, the firm issues equity if the financing need is high. This result is robust to using the cash for an uncertain investment. Second, firms can disguise the sale of a low-quality asset as instead motivated by operational reasons – dissynergies – and thus receive a higher price (the “camouflage effect”). Third, selling equity implies a “lemons” discount for not only the equity issued but also the rest of the firm, since its value is perfectly correlated. In contrast, a “lemons” discount on assets need not lead to a low stock price, as the asset is not a carbon copy of the firm (the “correlation effect”).

One of a firm’s most important decisions is how to raise financing. Most existing research on this topic focuses on the choice between debt and equity. For example, the pecking-order theory of Myers (1984), motivated by the model of Myers and Majluf (1984), posits that managers issue securities with least information asymmetry, and the market timing theory of Baker and Wurgler (2002) suggests that managers sell securities that are most mispriced. However, another major source of financing is relatively unexplored: selling non-core assets – divisions, physical capital, or financial investments. Asset sales are substantial in practice: Securities Data Corporation records \$131bn of asset sales by non-financial firms in the U.S. in 2012, versus \$81bn in seasoned equity issuance. Figure 12 compares the time series of seasoned equity issuance with asset sales.

While some of these sales may have been motivated by operational reasons, financing is a key driver of many others. Empirically, asset sales are used to fund new investment and R&D (shown by Hovakimian and Titman (2006) and Borisova and Brown (2013) respectively),



Figure 12: Seasoned equity issuance and asset sales volume. Seasoned equity is all US non-IPO equity issuance. Asset sales are completed, domestic M&A transactions labeled “acquisition of assets” or “acquisition of certain assets,” where the acquisition technique field includes at least one out of *Divestiture*, *Property Acquisition*, *Auction*, *Internal Reorganization*, *Spinoff*, and none out of *Buyout*, *Bankrupt*, *Takeover*, *Restructuring*, *Liquidation*, *Private*, *Tender*, *Unsolicited*, *Failed*. Source: SDC.

recapitalize firms in response to regulatory or investor concerns (as demonstrated by banks worldwide since the financial crisis¹), and address one-time cash needs (BP targeted \$45bn in asset sales to cover the costs of the Deepwater Horizon disaster).²

In each of the above cases, the firms could have met their financing needs through issuing securities, yet chose to sell assets. Indeed, Hite et al. (1987) examine the stated motives for asset sales and note that “in several cases ... selling assets was viewed as an alternative to the sale of new securities.” On the one hand, asset sales are a source of funds like security issuance, and should be considered alongside security issuance in a financing decision. On the other hand, unlike security issuance, asset sales can have real effects by reallocating physical resources and changing the firm’s boundaries. Thus, the role of asset sales in financing requires special investigation.

This paper analyzes the role of asset sales in financing, in a model that allows for them to be undertaken not only to raise capital, but also for operational reasons (dissynergies). It studies the conditions under which asset sales are preferable to equity issuance, how financing and operational motives interact, and how firm boundaries are affected by financial constraints. Our model is tractable and parsimonious, enabling its economic forces to be transparent. We analyze a firm that comprises a core asset and a non-core asset, and has a financing need which it can meet by selling either equity or part of the non-core asset. The firm’s type is privately known to its manager and comprises two dimensions. The first is quality, which determines the assets’ standalone (common) values. The value of the core asset is higher for high-quality firms. The value of the non-core asset depends on how we specify the correlation between the core and non-core assets. With a positive (negative) correlation, the value of the non-core asset is higher (lower) for high-quality firms. The

¹In September 2011, BNP Paribas and Société Générale announced plans to raise \$96 billion and \$5.4 billion respectively through asset sales, to create a financial buffer against contagion from other French banks. Bank of America raised \$3.6 billion in August 2011 by selling a stake in a Chinese construction bank, and \$755 million in November 2011 from selling its stake in Pizza Hut.

²More generally, Borisova et al. (2013) find that over half of asset sellers state financing motives. Campello et al. (2010) report that 70% of financially constrained firms increased asset sales in the financial crisis, versus 37% of unconstrained firms. Maksimovic and Phillips (1998) find a significant increase in asset sales upon bankruptcy.

second dimension is synergy: the additional value that the non-core asset is worth to its current owner.

It may seem that asset sales can already be analyzed by applying the general principles of the Myers and Majluf (1984) security issuance model to assets, removing the need for a new theory specific to asset sales. Such an extension would suggest that assets are preferred to equity if and only if they exhibit less information asymmetry. Our model identifies three new forces that also drive the financing choice and may outweigh information asymmetry considerations.

The first new force is the *certainty effect*, which represents an advantage to selling equity. It arises because new shareholders obtain a stake in the firm's entire balance sheet, which includes not just the core and non-core assets in place (whose value is uncertain), but also the cash raised. Since the value of the cash injected is certain, this mitigates the information asymmetry of the assets in place. In contrast, an asset purchaser does not share in the cash raised, and thus bears the full information asymmetry associated with the asset's value. Thus, the certainty effect is quite different from simply reducing the information asymmetry of the assets in place, which would benefit both asset purchasers and equity investors equally. Unlike in Myers and Majluf (1984), even if the firm's overall assets exhibit more information asymmetry than the non-core asset alone, the manager may sell equity if enough cash is raised that the certainty effect dominates. Contrary to conventional wisdom, equity is not always the riskiest claim: if a large amount of financing is raised, equity becomes relatively safe.

This finding implies that the source of financing depends on the amount required. Formally, a pooling equilibrium is sustainable where all firms sell assets (equity) if the financing need is sufficiently low (high). This dependence contrasts standard financing models, where the choice depends only on the characteristics of each claim (such as its information asymmetry, (Myers and Majluf (1984)) or misvaluation (Baker and Wurgler (2002)) and not the amount required – unless one assumes exogenous limits such as debt capacity.

The certainty effect applies to any use of cash whose expected value is uncorrelated with firm quality: retaining it on the balance sheet to replenish capital, repaying debt, or financing a risky investment whose expected return is independent of firm quality. We also analyze the case in which the investment's expected return is correlated with firm quality. It may appear that an uncertain investment return should weaken the certainty effect, but this intuition is incomplete due to a second consideration. Since investment is positive-NPV, it increases the value of the capital that investors are injecting: the certain value to which they have a claim is now higher. If the value created by investment (for firms of both quality) is large compared to the additional return generated by the high-quality firm over the low-quality firm, the second consideration dominates – somewhat surprisingly, the certainty effect can strengthen when cash is used to finance an uncertain investment. Thus, equity is more common when growth opportunities are good for firms of all quality: the source of financing depends on the use of financing. Indeed, equity is prevalent among young, growing firms (Frank and Goyal (2003), Fama and French (2005)). In contrast, if the additional return generated by the high-quality firm is large, asset sales become preferable. In almost all cases, it remains robust that asset (equity) sales are used for low (high) financing needs.

In addition to pooling equilibria, we may also have a semi-separating equilibrium where firms sell assets if synergies are below a threshold and equity otherwise. The threshold synergy level is different for high- and low-quality firms, due to the certainty effect. Moreover, this threshold level depends on the financing need: financial and operational motives interact. If the amount of financing required is low, the information asymmetry of equity is high, making it less (more) attractive to high (low) quality firms. Conventional wisdom is that higher financing needs cause all firms to sell more assets, which has negative real effects if assets are synergistic. Our model allows firms to raise capital also through equity; higher financing needs lead to high-quality firms substituting away from asset sales into equity issuance. Separately, greater financing needs reduce the quality, and thus price, of assets traded in equilibrium, and increase the quality and price of equity. The market reaction to equity (asset) sales is more (less) positive for a larger sale.

The second new force is the *camouflage effect*, which represents an advantage to selling assets. It arises if firms have the option not to raise financing and instead to forgo a growth opportunity. If the growth opportunity is low, high-quality firms will not issue equity, since the only motive to do so is to invest, but the value of investment is too low to outweigh the adverse selection discount. However, they will sell assets if they are sufficiently dissynergistic, not to finance investment but for operational reasons. Asset sales by high-quality firms allow low-quality firms to pool with them: they can camouflage an asset sale driven by overvaluation (the asset is of low quality and has a low common value) as instead being driven by operational reasons (it is dissynergistic and only has a low private value). Thus, low-quality firms also prefer asset sales – they will sell assets even if they are moderately synergistic, to take advantage of the camouflage. In the 1980s, many conglomerates shed non-core assets, stating a desire to refocus on the core business, but outsiders did not know if the true motivation was that the non-core assets were low-quality. In contrast, where growth opportunities are high, equity also provides camouflage as it can be undertaken for the operational reason of wishing to finance investment. Thus, we again get the prediction that young, growing firms are more likely to issue equity.

The third new force is the *correlation effect*, which also represents an advantage to selling assets. An equity issuer suffers an Akerlof (1970) “lemons” discount – the market infers that the equity is low-quality from the firm’s decision to issue it. The firm suffers not only a low price for the equity issued, but also a low valuation for the rest of the company, because it is perfectly correlated with the issued equity. An asset seller similarly receives a low price on the assets sold, but critically this need not imply a low valuation for the company as it need not be a carbon copy. Formally, in the negative correlation model, the parameter values that support the equity-pooling equilibrium are a strict subset of those that support asset-pooling. For example, to cover the costs of Deepwater Horizon, BP is selling its mature fields and refocusing on high-risk exploration. The *New York Times* reported that analysts perceived this sale as a bet on a major new find that would displace the existing fields.³

³See the articles “With Sale of Assets, BP Bets on More Deep Wells” (July 20, 2010) and “BP to Sell

The sale conveyed negative information about the mature fields but a positive signal about the rest of the firm.

An implication of the correlation effect is that conglomerates issue equity less often, and sell assets more often, than firms with closely related divisions. In addition, asset sales (equity issuance) lead to positive (negative) market reactions, as found empirically. The analysis also highlights a new benefit of diversification: a non-core asset is a form of financial slack. While the literature on investment reversibility (e.g., Abel and Eberly (1996)) models reversibility as a feature of the asset’s technology, here an investment that is not a carbon copy of the firm is “reversible” in that it can be sold without negative inferences on the rest of the firm.

Our paper can be interpreted more broadly as studying at what *level* to issue claims: the firm level (equity issuance) or the asset level (asset sales). Our effects also apply to other *types* of claim that the firm can issue at each level. All three effects apply to parent-company risky debt (or general securities issued against the firm’s balance sheet, as analyzed by DeMarzo and Duffie (1999)) in the same way as parent-company equity: since parent-company debt is also a claim to the entire firm, it benefits from the certainty effect and is positively correlated with firm value; issuing debt cannot be camouflaged as stemming from operational reasons. Like asset sales, the issuance of asset- or division-level debt or equity (e.g. an equity carve-out) benefits from the correlation effect as it need not imply low quality for the firm as a whole, but not the certainty effect as investors do not own a claim to the cash they invest, which resides at the parent company level.

Most existing literature on asset sales is empirical. Jain (1985), Klein (1986), Hite et al. (1987), and Slovin et al. (1995) find positive market reactions to asset sales. Lang et al. (1995) show that this positive reaction stems from financing rather than operational reasons. Brown et al. (1994) and Bates (2006) examine the use of proceeds. Maksimovic and Phillips (2001) and Eisfeldt and Rampini (2006) analyze operational rather than financing motives.

Oil Assets in Gulf of Mexico for \$5.6 billion” (September 10, 2012).

Existing theories generally consider asset sales as the only source of financing and do not compare them to equity, e.g., Shleifer and Vishny (1992), DeMarzo (2005), He (2009), and Kurlat (2013). Murfin (2012) and Bond and Leitner (2014) show that selling an asset will affect the market price of the seller’s remaining portfolio under mark-to-market accounting. We show that such correlation effects are stronger for equity: while a partial asset sale may imply a negative valuation of the remaining unsold non-core assets, it need not imply a negative valuation of the firm. Nanda and Narayanan (1999) also consider both asset sales and equity issuance under information asymmetry, but do not feature the certainty, camouflage, or correlation effects.⁴

Since a partial asset sale can be interpreted as a carve-out, our paper is also related to the carve-out literature. Nanda (1991) also notes that non-core assets may be uncorrelated with the core business and that this may motivate subsidiary equity issuance. In his model, correlation is always zero and the information asymmetry of core and non-core assets is identical. Our model allows for general correlations and information asymmetries, as well as synergies, enabling us to generate the three effects.⁵

Finally, while we show that the Myers and Majluf (1984) pecking order insight cannot be naturally extended to the choice between asset sales and equity, Nachman and Noe (1994) show that the original pecking order (between debt and equity) only holds under special conditions. Fulghieri et al. (2013) demonstrate that these conditions are particularly likely to be violated for younger firms with larger investment needs and riskier growth

⁴Leland (1994) allows firms to finance cash outflows either by equity issuance (in the core analysis) or by asset sales (in an extension), but not to choose between the two. In Strebulaev (2007), asset sales are assumed to be always preferred to equity issuance, which is a last resort. Other papers model asset sales as a business decision (equivalent to disinvestment) and do not feature information asymmetry. In Morellec (2001), asset sales occur if the marginal product of the asset is less than its (exogenous) resale value. In Bolton et al. (2011), disinvestment occurs if the cost of external finance is high relative to the marginal productivity of capital. While those papers take the cost of financing as given, this paper microfound the determinants of the cost of equity finance versus asset sales.

⁵Empirically, Allen and McConnell (1998) study how the market reaction to carve-outs depends on the use of proceeds. Schipper and Smith (1986) show that equity issuance leads to negative abnormal returns, but carve-outs lead to positive returns. Slovin et al. (1995) find positive market reactions to carve-outs, and Slovin and Sushka (1997) study the implications of parent and subsidiary equity issuance on the stock prices of both the parent and the subsidiary.

opportunities, where equity is indeed preferred to debt empirically.

This paper is organized as follows. Section 2.1 outlines the general model. Sections 2.2 and 2.3 study the positive and negative correlation cases, respectively. Section 2.4 discusses empirical implications and Section 2.5 concludes. The remaining sections contain proofs, extensions, and other peripheral material.

2.1. The Framework

The model consists of two types of risk-neutral agent: firms, which raise financing, and investors, who provide financing and set prices. The firm is run by a manager, who has private information about the firm's type $\theta = (q, k)$. The type θ consists of two dimensions. The first is the firm's quality $q \in \{H, L\}$, which measures the standalone (common) value of its assets. The prior probability that $q = H$ is $\pi \in (\frac{1}{2}, 1)$. The second dimension is a synergy parameter $k \sim U[\underline{k}, \bar{k}]$, where $-1 < \underline{k} \leq 0$, $\bar{k} \geq 0$, and k and q are uncorrelated. This parameter measures the additional (private) value created by the existing owner.

The firm comprises two assets. The core business has value C_q , where $C_H > C_L$, and the non-core business has value A_q . Where there is no ambiguity, we use the term "assets" to refer to the non-core business. We consider two specifications of the model. The first is $A_H > A_L$, so that the two assets are positively correlated. The second is $A_L > A_H$, so that they are negatively correlated. If $A_H = A_L$, the non-core asset exhibits no information asymmetry and so it is automatic that firms will raise financing by selling it. In both cases, we assume:

$$C_H + A_H > C_L + A_L, \tag{2.1}$$

i.e., H has a higher total value even if $A_H < A_L$. In Myers and Majluf (1984), the key driver of financing is information asymmetry. The distinction between the two cases of $A_H > A_L$ and $A_H < A_L$ shows that it is not only the information asymmetry of the non-core asset that matters ($|A_H - A_L|$), but also its correlation with the core asset ($\text{sign}(A_H - A_L)$).⁶

⁶He (2009) considers a different multiple-asset setting where the value of each asset comprises a component

We consider an individual firm, which must raise financing of F .⁷ The cash raised remains on the firm's balance sheet. This modeling treatment nests any financing need that increases expected firm value by F , such as replenishing capital, repaying debt, or financing an uncertain investment whose expected value is uncorrelated with q .⁸

We initially treat the financing decision as exogenous. In Myers and Majluf (1984), the firm has the option not to raise financing and instead to forgo investment; their goal was to show that information asymmetry can deter investment by hindering financing. Since this effect is now well-known, our initial focus is instead the choice between asset sales and equity issuance to meet a given financing need. Section 2.2.2 gives firms the choice of whether to raise financing; it also allows the cash to be used to finance an investment whose return is correlated with q and thus exhibits information asymmetry.

The firm can raise F by selling either non-core assets or equity. It cannot sell the core asset as it is essential to the firm (Section 2.7 relaxes this assumption) and it has exhausted other sources of finance such as risk-free debt capacity. As will be made clear later, the same certainty, camouflage, and correlation effects that drive the choice between equity and asset sales will also drive the choice between risky debt and asset sales.

We specify $F \leq \min(A_L, A_H)$, so that the financing can be raised entirely through either source.⁹ If the amount of financing exceeds the non-core assets available, the firm would mechanically be forced to use equity and so the source of financing would automatically depend on the amount of financing required. In our equilibria, firms use a single source of

known to the seller, and an unknown component. The (known) correlation refers to the correlation between the unknown components, whereas here it refers to the correlation between the total values of the assets (which are known to the seller). His model considers asset sales but not equity issuance.

⁷The amount of financing F does not depend on the source of financing: F must be raised regardless of whether the firm sells assets or equity. In bank capital regulation, equity issuance leads to a greater improvement in capital ratios than asset sales and so F does depend on the source of financing. We do not consider this effect as it will be straightforward: it will encourage H towards the source that reduces the amount of financing required, and thus force L to follow in order to pool.

⁸If the expected value of the investment is F , all expressions are unchanged. If the expected value is F' , F is simply replaced by F' in all expressions: the relevant variable becomes the (common) expected value of the investment instead of the amount of cash required to finance it.

⁹Some of the analysis in the paper will derive bounds on F for various equilibria to be satisfied. We have verified that none of these bounds are inconsistent with $F \leq \min(A_L, A_H)$.

financing. Section 2.8 proves that the off-equilibrium path belief (“OEPB”), that a firm that uses multiple sources is of quality L , satisfies the Cho and Kreps (1987) Intuitive Criterion (“IC”). The restriction could alternatively be motivated by the transactions costs of using multiple sources. We abstract from differences between asset sales and equity issuance in taxes, transactions costs, liquidity, bargaining power, and other frictions, because they will affect the financing choice in obvious ways: the firm will lean towards the financing source that exhibits fewest frictions. Firms cannot raise financing in excess of F ; this assumption can be justified by forces outside the model such as agency costs of free cash flow.

The non-core asset is perfectly divisible so partial asset sales are possible; we do not feature nonlinearities as they will mechanically lead to the source of financing depending on the amount required. If a firm sells non-core assets with a true value of \$1, its fundamental value falls by $\$1 + k$. Thus, the case of $k > (<) 0$ represents synergies (dissynergies), where the asset is worth more (less) to the current owner than a potential purchaser. That $\underline{k} \leq 0$ allows for asset sales to be motivated by operational reasons (dissynergies) rather than only financing reasons.¹⁰ Synergies mean that non-core assets may be worth more or less to the current owner than to an outside purchaser, even in the absence of information asymmetry. They may stem from transactions costs being lower within a firm than in a market (Coase (1937)), monitoring advantages (Alchian and Demsetz (1972)), economies of scope (Panzar and Willig (1981)), a reduction in hold-up problems (Grossman and Hart (1986)), or firm-specificity. In addition to synergies, $k > 0$ can also arise if investment in assets is costly to reverse (e.g. Abel and Eberly (1996)).

Formally, a firm of quality q issues a claim $X \in \{E, A\}$, where $X = E$ represents equity and $X = A$ assets. Investors are perfectly competitive and infer q based on X . Thus, they price

¹⁰One may wonder why the firm will have dissynergistic assets to begin with. Firms may acquire assets when they are synergistic, but they may become dissynergistic over time. One may still wonder why the firm has not yet disposed of the dissynergistic asset. First, the firm may retain it due to the transactions costs of asset sales: only if it is forced to raise financing and so would have to bear the transactions costs of equity issuance otherwise, would it consider selling assets. Second, the market for assets is not perfectly frictionless, and so not all assets are owned by the best owner at all times. Our model allows for $\underline{k} = 0$ in which case there are no dissynergies; more generally, our model specifies that synergies are not so strong as to overwhelm the other forces in the model.

both the claim being sold and the firm's stock at their expected values conditional upon X . The price received for the claim affects the firm's fundamental value. The manager's objective function places weight ω on the firm's stock price and $1 - \omega$ on its fundamental value. The manager's stock price concerns can stem from a number of sources introduced in earlier work, such as takeover threat (Stein (1988)), reputational concerns (Narayanan (1985), Scharfstein and Stein (1990)), or the manager expecting to sell his shares before fundamental value is realized (Stein (1989)).

A useful feature of the framework is that only quality q , and not synergy k , directly affects the investor's valuation of a claim and thus the price paid. This allows our model to incorporate two dimensions of firm type – quality and synergy – while retaining tractability. We sometimes use the term “ H ” or “ H -firm” to refer to a high-quality firm regardless of its synergy parameter, and similarly for “ L ” or “ L -firm”. “Capital gain/loss” refers to the gain/loss resulting from the common value component of the asset value only, and “fundamental gain/loss” refers to the change in the firm's overall value, which consists of both the capital gain/loss and any loss of (dis)synergies. For equity issuance, the capital gain/loss equals the fundamental gain/loss.

We solve for pure strategy equilibria.¹¹ We use the Perfect Bayesian Equilibrium (“PBE”) solution concept, where: (i) Investors have a belief about which firm qualities issue which claim X ; (ii) The price of the claim being issued equals its expected value, conditional on investors' beliefs in (i); (iii) Each manager chooses to issue the claim X that maximizes his objective function, given investors' beliefs; (iv) Investors' beliefs satisfy Bayes' rule. In addition to the PBE, beliefs on claims X issued off the equilibrium path satisfy the IC.

We first analyze the positive correlation version of the model ($A_H > A_L$) and then move to negative correlation ($A_L > A_H$).

¹¹Mixed strategy equilibria only exist for the type that is exactly indifferent between the two claims. Since synergies are continuous, this type is atomistic and so it does not matter for posterior beliefs whether we specify this cutoff type as mixing or playing a pure strategy.

2.2. Positive Correlation

We set $\omega = 0$ in the positive correlation model for ease of exposition, so that the manager maximizes fundamental value. There is a nontrivial role for $\omega > 0$ only under negative correlation, in which case a trade-off exists to being inferred as L : market valuation falls, but the firm receives a high price if it sells assets. With a positive correlation, there is no such trade-off: being inferred as L worsens both market and fundamental values. Allowing for general ω only adds additional terms to the inequalities, but does not affect their directions or the set of sustainable equilibria.

Section 2.2.1 studies the core model outlined in Section 2.1, where firms are forced to raise capital (e.g. to meet a liquidity need). In Section 2.2.2, firms have the choice of whether to raise capital, to finance an investment whose expected value exhibits information asymmetry.

2.2.1. Mandatory Capital Raising

We first consider pooling equilibria (PE), which are of two types: an asset-pooling equilibrium (APE) and an equity-pooling equilibrium (EPE). We then move to semi-separating equilibria (SSE). The analysis studies the conditions under which the different equilibria are sustainable, to predict when firms will use each financing channel. The pooling equilibria will demonstrate the certainty effect: equity investors obtain a claim to the cash raised, which mitigates the information asymmetry of equity. As a result, low financing needs are met by asset sales and high financing needs by equity issuance.

2.2.1.1 Pooling Equilibrium, All Firms Sell Assets

We consider a pooling equilibrium in which all firms sell assets, supported by the OEPB that an equity issuer is of quality L . Assets are valued at

$$\mathbb{E}[A] = \pi A_H + (1 - \pi)A_L. \quad (2.2)$$

If equity is sold (off the equilibrium path), it is valued at E_L , where

$$E_q = C_q + A_q + F$$

is the value of equity for a firm of quality q . The F term arises because the cash raised enters the balance sheet, and so new shareholders own a claim to it.

The fundamental values of H and L , given synergies of k , are respectively given by:

$$C_H + A_H - F \frac{(1 - \pi)(A_H - A_L) + kA_H}{\mathbb{E}[A]}, \quad (2.3)$$

$$C_L + A_L + F \frac{\pi(A_H - A_L) - kA_L}{\mathbb{E}[A]}. \quad (2.4)$$

L enjoys a capital gain of $F \frac{\pi(A_H - A_L)}{\mathbb{E}[A]}$ by selling low-quality assets at a pooled price, and so he will not deviate. However, he loses the synergies from the asset. If

$$1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L}, \quad (2.5)$$

then even the L -firm with the greatest synergies, type (L, \bar{k}) , is willing to sell assets, since the capital gain exceeds the synergy loss. Equation (2.5) is necessary and sufficient for all L -firms not to deviate.

H suffers a capital loss of $F \frac{(1 - \pi)(A_H - A_L)}{\mathbb{E}[A]}$, and thus may deviate to equity. If he does so, fundamental value becomes:

$$C_H + A_H - F \frac{C_H - C_L + A_H - A_L}{C_L + A_L + F}. \quad (2.6)$$

The no-deviation (“ND”) condition is that (2.6) \leq (2.3). This condition is most stringent for type (H, \bar{k}) . Thus, no H -firms will deviate if:

$$F \leq F^{APE, ND} \equiv \frac{\mathbb{E}[A](C_H + A_H) - A_H(C_L + A_L)(1 + \bar{k})}{A_H(1 + \bar{k}) - \mathbb{E}[A]}. \quad (2.7)$$

Condition (2.7) is equivalent to the “unit cost of financing” being lower for assets, i.e.,

$$\frac{A_H (1 + \bar{k})}{\mathbb{E}[A]} \leq \frac{C_H + A_H + F}{C_L + A_L + F}, \quad (2.8)$$

where the numerator on each side is the value of the claim being sold by the firm, and the denominator is the price that investors pay for that claim.

Three forces determine H ’s incentives to deviate. The first is whether assets or equity exhibit greater information asymmetry ($\frac{A_H}{\mathbb{E}[A]}$ versus $\frac{C_H + A_H}{C_L + A_L}$). This effect is a natural extension of the Myers and Majluf (1984) principle that high-quality firms issue safe claims. Indeed, without synergies ($\bar{k} = 0$), then if $\frac{A_H}{\mathbb{E}[A]} > \frac{C_H + A_H}{C_L + A_L}$, i.e., assets exhibit sufficiently greater information asymmetry, H will deviate to equity: for any F , (2.8) is violated and so an APE is unsustainable.

The second force is synergies. For APE to hold, firms must be willing to sell assets despite the loss of synergies. Thus, we require the maximum synergy level to be small. If $1 + \bar{k} > \frac{(C_H + A_H)\mathbb{E}[A]}{(C_L + A_L)A_H}$, then again (2.8) is violated and so APE is unsustainable for any F .

The third force is the amount of financing F . This is unique to a model of asset sales and arises because an equity investor has a claim to the cash raised but an asset purchaser does not. Since the value of cash is certain, it mitigates the information asymmetry of equity: the *certainty effect*. As F rises, the right-hand side (“RHS”) of (2.8) becomes dominated by the term F (which is the same in the numerator and the denominator as it is known) and less dominated by the unknown assets-in-place terms C_q and A_q (which differ between the numerator and denominator), so the RHS falls towards 1. Thus, there is an upper bound on F to prevent deviation, given by (2.7). If F exceeds this bound, the certainty effect is sufficiently strong that (H, \bar{k}) deviates to equity. In particular, even if $\frac{A_H}{\mathbb{E}[A]} < \frac{C_H + A_H}{C_L + A_L}$ and $\bar{k} = 0$, i.e., assets are safer than equity and there are no synergies, a high F can lead to (2.8) being violated. The Myers and Majluf (1984) result that firms issue the claim with the least information asymmetry need not hold. Similarly, the analysis contradicts

conventional wisdom that equity is the riskiest claim. If the amount of financing raised is sufficiently large, equity is relatively safe. One interesting case is a single-segment firm, which corresponds to $C_q = A_q$, i.e., core and non-core assets are one and the same. Since the information asymmetry of the firm equals that of the non-core asset, the certainty effect will push the information asymmetry of equity lower, and so APE is never sustainable for any F .

Note that the certainty effect would also apply to risky debt, since it is also a claim on the entire balance sheet. Thus, even if risky debt exhibits more information asymmetry than the non-core asset, it may be preferred if F is large.

We now verify that the OEPB, that an equity issuer is of type (L, \bar{k}) , satisfies the IC. This is the case if (L, \bar{k}) would issue equity if inferred as H , i.e.:

$$F \leq F^{APE, IC} \equiv \frac{A_L(C_H + A_H)(1 + \bar{k}) - \mathbb{E}[A](C_L + A_L)}{\mathbb{E}[A] - A_L(1 + \bar{k})}. \quad (2.9)$$

If F is large, L will not deviate to equity even if he is inferred as H , since the certainty effect reduces the gains from doing so. Thus, we have another upper bound on F .

Lemma 1 below summarizes the equilibrium. The proof shows that, if and only if $1 + \bar{k} < \frac{\mathbb{E}[A]}{\sqrt{A_H A_L}} (> 1)$, the IC condition is stronger than the ND condition and thus is the relevant condition for an APE to hold. (All proofs are in Section 2.6.)

Lemma 1. *(Positive correlation, pooling equilibrium, all firms sell assets.) Consider a pooling equilibrium where all firms sell assets ($X = A$) and a firm that issues equity is inferred as (L, \bar{k}) . The prices of assets and equity are $\pi A_H + (1 - \pi)A_L$ and $C_L + A_L + F$, respectively. The equilibrium is sustainable if the following conditions hold:*

$$(i) \ 1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L},$$

(ii) $F \leq F^{APE}$, where

$$F^{APE} = \begin{cases} F^{APE,IC} \equiv \frac{A_L(C_H + A_H)(1 + \bar{k}) - \mathbb{E}[A](C_L + A_L)}{\mathbb{E}[A] - A_L(1 + \bar{k})} & \text{if } 1 + \bar{k} \leq \frac{\mathbb{E}[A]}{\sqrt{A_H A_L}} \\ F^{APE,ND,H} \equiv \frac{\mathbb{E}[A](C_H + A_H) - A_H(C_L + A_L)(1 + \bar{k})}{A_H(1 + \bar{k}) - \mathbb{E}[A]} & \text{if } 1 + \bar{k} \geq \frac{\mathbb{E}[A]}{\sqrt{A_H A_L}}. \end{cases} \quad (2.10)$$

2.2.1.2 Pooling Equilibrium, All Firms Sell Equity

We now consider the alternative pooling equilibrium in which all firms issue equity, supported by the OEPB that an asset seller is of quality L . The analysis is similar to the APE and the equilibrium is summarized in Lemma 2 below.

Lemma 2. *(Positive correlation, pooling equilibrium, all firms sell equity.) Consider a pooling equilibrium where all firms sell equity ($X = E$) and a firm that sells assets is inferred as (L, \underline{k}) . The prices of assets and equity are A_L and*

$$\mathbb{E}[E] = \pi(C_H + A_H) + (1 - \pi)(C_L + A_L) + F, \quad (2.11)$$

respectively. This equilibrium is sustainable if the following conditions hold:

$$(i) \ 1 + \underline{k} > \max\left(\frac{A_L}{A_H}, \frac{E_L}{\mathbb{E}[E]}\right),$$

(ii) $F \geq F^{EPE}$, where

$$F^{EPE} = \begin{cases} F^{EPE,IC} \equiv \frac{A_L \mathbb{E}[C + A](1 + \underline{k}) - A_H(C_L + A_L)}{A_H - A_L(1 + \underline{k})} & \text{if } 1 + \underline{k} \geq \frac{A_H A_L}{\mathbb{E}[A^2]} \\ F^{EPE,ND,H} \equiv \frac{A_L(C_H + A_H) - A_H \mathbb{E}[C + A](1 + \underline{k})}{A_H(1 + \underline{k}) - A_L} & \text{if } 1 + \underline{k} \leq \frac{A_H A_L}{\mathbb{E}[A^2]}. \end{cases} \quad (2.12)$$

In contrast to Section 2.2.1.1, H 's ND condition in (2.12) now imposes a *lower* bound on F . This also results from the certainty effect. If F is high, equity exhibits little information asymmetry. Thus, H suffers a small loss from equity issuance, and so will not deviate. The IC condition also involves a lower bound for a similar reason.

Section 2.7 shows that the certainty effect is robust to allowing firms to sell the core asset

(in addition to the non-core asset and equity). The intuition is as follows. One of the assets (core or non-core) will exhibit more information asymmetry than the other; since equity is a mix of both assets, its information asymmetry will lie in between. Even though equity is never the safest claim, it may still be issued due to the certainty effect: an *EPE* can be sustained.

2.2.1.3 Semi-Separating Equilibria

In a *SSE*, the financing choice depends on the synergy parameter k : there is a cutoff k_q^* where any firm below (above) the cutoff sells assets (equity). H and L can use different cutoff rules, so separation will be along both type dimensions. In the limit case of $\bar{k} = \underline{k} = 0$, there is no synergy parameter to separate along, and so this subsection considers the case where \bar{k} is strictly greater than \underline{k} .

The equilibria are summarized in Lemma 3 below.

Lemma 3. *(Positive correlation, synergies, semi-separating equilibrium): Consider a semi-separating equilibrium where quality q sells assets if $k \leq k_q^*$ and equity if $k > k_q^*$, and define $F^* \equiv \frac{C_H A_L - C_L A_H}{A_H - A_L}$. We have the following cases:*

(i) *If $F < F^*$, then $k_H^* > 0$ and $k_L^* > k_L^*$.*

(ii) *If $F > F^*$, then $k_H^* < 0$ and $k_L^* < k_L^*$.*

(iii) *If $F = F^*$, then $k_L^* = k_H^* = 0$.*

A separating equilibrium is sustainable if both (a) \underline{k} is sufficiently low or \bar{k} is sufficiently high, and (b) F is sufficiently close to F^ ; specific conditions are given in Section 2.6. The*

prices of assets and equity are given by:

$$\mathbb{E}[A|X = A] = \pi \frac{k_H^* - \underline{k}}{\mathbb{E}[k_q^*] - \underline{k}} A_H + (1 - \pi) \frac{k_L^* - \underline{k}}{\mathbb{E}[k_q^*] - \underline{k}} A_L, \quad (2.13)$$

$$\mathbb{E}[E|X = E] = \pi \left(\frac{\bar{k} - k_H^*}{\bar{k} - \mathbb{E}[k_q^*]} \right) (C_H + A_H) + (1 - \pi) \left(\frac{\bar{k} - k_L^*}{\bar{k} - \mathbb{E}[k_q^*]} \right) (C_L + A_L) + F, \quad (2.14)$$

where

$$\mathbb{E}[k_q^*] = \pi k_H^* + (1 - \pi) k_L^*.$$

Lemma 3 states that it is the relative importance of operational motives (the absolute values of \bar{k} and \underline{k}) compared to certainty effect-adjusted information asymmetry (the distance of F from F^*) that governs whether a *SSE* is sustainable. In a *SSE*, both claims are issued and one claim will be associated more with L . If F is very low or very high, information asymmetry is strong, and so issuing the claim associated with L leads to a large capital loss. If synergies are too weak to offset this loss, firms pool. In contrast, if F is close to F^* and \bar{k} or \underline{k} is extreme, synergy motives are strong, and so firms of the same quality issue different claims depending on k .

In addition, Lemma 3 gives conditions under which $k_H^* > k_L^*$, i.e. H prefers asset sales. The condition that $F < F^*$ requires certainty effect-adjusted information asymmetry to be higher for equity, which in turn requires F to be low. H dislikes information asymmetry as it increases his capital loss; conversely, L likes information asymmetry. If $F < F^*$, equity is less attractive to H than L , and so H chooses a higher cutoff ($k_H^* > k_L^*$). Indeed, when $F < F^*$, we have $k_H^* > 0$: H sells assets even if they are mildly synergistic, due to their lower information asymmetry. The different cutoffs in turn affect the valuations. If $k_H^* > k_L^*$, H is more willing to sell assets than L , and so the asset price (2.13) is higher than in the *APE* (2.2).

Due to the certainty effect, changes in F alter the cutoffs and thus the quality of assets

and equity sold, in turn affecting their prices. If $F > F^*$, the certainty effect is sufficiently strong that equity is more attractive to H ($k_H^* < k_L^*$). More H firms sell equity, increasing (decreasing) the quality and price of equity (assets) sold. Indeed, when $F > F^*$, we have $k_H^* < 0$: H retains assets even if they are mildly dissynergistic, due to their higher information asymmetry. Now, the equity price (2.14) is higher than in the EPE (2.11). Thus, just as in the PE s, increases in F have real effects on firm boundaries. Here, they lead to more H -firms retaining assets, even if they are dissynergistic. Financing and operational motives interact – financial constraints affect the cutoff level of synergy required for a firm to sell assets, and greater financial constraints reduce the affect the quality of assets sold in the real assets market.

2.2.1.4 Comparing the Equilibria

We now analyze the conditions under which each equilibrium is sustainable. The results are given in Proposition 1 below:

Proposition 1. *(Positive correlation, comparison of equilibria.)*

(i) If $1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L}$ or $1 + \underline{k} > \max\left(\frac{A_L}{A_H}, \frac{E_L}{\mathbb{E}[E]}\right)$, at least one pooling equilibrium is sustainable.

If both inequalities hold:

(ia) An asset-pooling equilibrium is sustainable if $F \leq F^{APE}$.

(ib) An equity-pooling equilibrium is sustainable if $F \geq F^{EPE}$.

(ic) $F^{APE} \geq F^{EPE}$. For $F^{EPE} \leq F \leq F^{APE}$, both pooling equilibria are sustainable.

(ii) For $F > F^*$, if $1 + \underline{k} < \frac{A_L}{A_H}$, then a SSE is sustainable. For $F < F^*$, if $1 + \bar{k} > \frac{E_H}{E_L}$, then a SSE is sustainable.

Part (i) of Proposition 1 states that pooling equilibria are sustainable if synergies are weak. Intuitively, deviation from a PE leads to being inferred as L ; if synergies are not strong enough to outweigh the capital loss, deviation is ruled out and so the PE holds. When the

amount of financing required increases, firms switch from selling assets (*APE*) to equity (*EPE*), since the certainty effect strengthens. Thus, the type of claim issued depends not only on the inherent characteristics of the claim (its information asymmetry) but also the amount of financing required. In standard theories, the type of security issued only depends on its characteristics (e.g., information asymmetry or overvaluation), unless one assumes exogenous limitations on financing such as limited debt capacity. Here, there are no limits as F can be fully raised by either source.

It may seem that, since financing is a motive for asset sales, greater financing needs should lead to more asset sales. This result is delivered by investment models where financial constraints induce disinvestment. Here, if F rises sufficiently, the firm may sell *fewer* assets, since it substitutes into an alternative source of financing: equity. The amount of capital required therefore affects firm boundaries. In the case in which all assets are synergistic, then asset sales reduce total surplus. Surprisingly, greater financial constraints may improve real efficiency as firms hold onto their synergistic assets.

Part (ii) reiterates the results of Lemma 3: if synergies are sufficiently strong relative to information asymmetry, a *SSE* is sustainable. Combining all parts of Proposition 1 together, if we fix synergies such that $1 + \bar{k} < \frac{\mathbb{E}[A]}{A_L}$ and $1 + \underline{k} > \max\left(\frac{A_L}{A_H}, \frac{E_L}{\mathbb{E}[E]}\right)$, as F rises, we move from *APE*, to a region in which both *PEs* hold, then to *EPE*.¹² In addition, in a neighborhood around F^* we also have *SSE*, so three equilibria (*APE*, *EPE*, and *SSE*) can be sustained. The change in equilibrium as F changes illustrates that H prefers assets (equity) if F is low (high). If we fix F and increase synergies in absolute terms, we move from a *PE* to a *SSE*.

2.2.2. Voluntary Capital Raising

This section gives firms the choice of whether to raise capital, and also allows the capital raised to finance a positive-NPV investment. These extensions naturally go together

¹²Eventually, when F becomes extreme, we have a *SSE* where all H -firms sell equity but L -firms sell either assets or equity depending on k . When F is very high, L -firms make little capital gain from equity, and so those with highly dissynergistic assets sell them.

since, if given the choice not to raise capital, a H -firm would never issue equity unless the capital raised could be used productively. The analysis will generate two results. First, it shows that the certainty effect of Section 2.2.1 continues to hold when the cash raised is used to finance an investment whose expected value exhibits information asymmetry.¹³ Second, it demonstrates the camouflage effect: firms will prefer to raise capital via asset sales rather than equity issuance, as they can disguise the capital raising as being motivated by operational reasons rather than overvaluation.

All firms can either do nothing, or instead raise capital of F to finance an investment with expected value $R_q = F(1 + r_q)$, where $r_H \geq 0$ and $r_L \geq 0$: since there are no agency problems, only positive-NPV investments are undertaken (as in Myers and Majluf (1984)). (Section 2.9 allows for $r_H < 0$ and $r_L < 0$ and shows that the core intuitions are unchanged.) We allow for both $r_H \geq r_L$ and $r_H < r_L$. The former is more common as high-quality firms typically have superior investment opportunities, but $r_H < r_L$ can occur as a firm that is currently weak may have greater room for improvement. Intuitively, it would seem that, if $r_H \geq r_L$, the uncertainty of investment will exacerbate the uncertainty of assets in place, weakening the certainty effect and making equity less desirable. However, we will show that this is not necessarily the case.

We now have $E_q = C_q + A_q + F(1 + r_q)$ and continue to assume $E_H > E_L$: i.e. even if $r_H < r_L$, the total value of the H -firm remains higher.

We also assume that:

$$\begin{aligned} \frac{\mathbb{E}[A]}{A_H} \times \frac{1 + r_L}{1 + r_H} &< 1 + \bar{k} < \frac{\mathbb{E}[A]}{A_L} \times \frac{1 + r_L}{1 + r_H}; \\ \frac{A_L}{A_H} \times \frac{1 + r_H}{\mathbb{E}[1 + r_q]} &< 1 + \underline{k} < \frac{A_H}{A_L} \times \frac{1 + r_L}{\mathbb{E}[1 + r_q]}. \end{aligned} \tag{2.15}$$

These are analogous to the bounds on synergies that we assumed in the core model: We

¹³Since all agents are risk-neutral, only expected values matter. Thus, the model of Section 2.2.1 is unchanged if we simply make the investment volatile, so that its payoff is a random variable with an expected value independent of q and so does not exhibit information asymmetry.

imposed $1 + \bar{k} < \frac{\mathbb{E}[A]}{A_L}$ in APE to ensure that there was not an L type with synergies so strong that he would always deviate to equity issuance regardless of informational motives. This is analogous to the second inequality in the first line above. Here, we also impose the first inequality to ensure the same for type H . This was unnecessary in the core model (as can be seen by evaluating the inequality for $r_H = r_L = 0$), but is necessary now because it could be the case that type L has extremely valuable investment opportunities relative to type H , leading to a positive inference about the quality of equity issued. If type H has the more valuable investment opportunity then the condition is again trivial.

For EPE, the first inequality in the second line above is analogous to the assumption $1 + \underline{k} > \frac{A_L}{A_H}$ in the core model, and the second was unnecessary in the core model but is necessary here. Intuitively, then, these conditions are equivalent to the bounds on synergies imposed in the core model, plus a requirement that the volatility of returns is not extremely high. Mechanically, these conditions guarantee that the denominators of the equilibrium bounds presented below will not be negative (which also implies that they will not reverse direction).

Lemma 4 gives conditions under which the *APE* is sustainable.

Lemma 4. *(Positive correlation, pooling equilibrium, all firms sell assets, capital raising is a choice.) Consider a pooling equilibrium where all firms sell assets ($X = A$) and a firm that issues equity is inferred as L . The prices of assets and equity are $\pi A_H + (1 - \pi)A_L$ and $C_L + A_L + F(1 + r_L)$, respectively. The equilibrium is sustainable if the following conditions hold:*

- (i) $1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L(1+r_L)}$, a stronger condition than when cash remains on the balance sheet (Lemma 1)
- (ii) $1 + r_H \geq \frac{A_H(1+\bar{k})}{\mathbb{E}[A]}$, a new condition not in Lemma 1.

(iii) $F \leq \min (F^{APE,ND,H,I}, F^{APE,IC,I})$, where

$$F^{APE,ND,H,I} \equiv \frac{\mathbb{E}[A](C_H + A_H) - A_H(C_L + A_L)(1 + \bar{k})}{A_H(1 + \bar{k})(1 + r_L) - \mathbb{E}[A](1 + r_H)}$$

$$F^{APE,IC,I} \equiv \frac{A_L(C_H + A_H)(1 + \bar{k}) - \mathbb{E}[A](C_L + A_L)}{\mathbb{E}[A](1 + r_L) - A_L(1 + \bar{k})(1 + r_H)}$$

Compared to Lemma 1, $F^{APE,ND,H}$ is looser if and only if $\frac{r_H}{r_L} > \frac{A_H(1+\bar{k})}{\mathbb{E}[A]}$ and $F^{APE,IC}$ is looser if and only if $\frac{r_H}{r_L} > \frac{\mathbb{E}[A]}{A_L(1+\bar{k})}$.

Condition (i) ensures that L firms do not deviate to doing nothing. Since L now loses the return on investment r_L from doing so, this condition is weaker than the condition in Lemma 1, part (i), which ensures that L does not deviate to issue equity. Condition (iii) ensures that H 's investment return is sufficiently high to deter him from deviating to doing nothing.

Turning to condition (ii), H 's ND condition, the analog of (2.8), is now:

$$\frac{A_H(1 + \bar{k})}{\mathbb{E}[A]} \leq \frac{C_H + A_H + F(1 + r_H)}{C_L + A_L + F(1 + r_L)}. \quad (2.16)$$

As is intuitive, C_q and $R_q (= F(1 + r_q))$ enter symmetrically in all expressions: an equity investor receives a share of C , R , and A , but an asset purchaser receives only a share of A .

We first consider the case of $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} > \frac{1+r_H}{1+r_L}$, i.e., the information asymmetry of investment is not too high. Then (2.16) again implies an upper bound on F :

$$F \leq \frac{\mathbb{E}[A](C_H + A_H) - A_H(C_L + A_L)(1 + \bar{k})}{A_H(1 + \bar{k})(1 + r_L) - \mathbb{E}[A](1 + r_H)} \quad (2.17)$$

In the core model (equation (2.7)), the denominator is $A_H(1 + \bar{k}) - \mathbb{E}[A]$. If $r_L > r_H$, the denominator of (2.17) is greater than in the core model, and so it is harder to support an APE . This is intuitive: L 's superior growth options counterbalance its inferior assets in place and reduce the information asymmetry of equity. One may think that the reverse

intuition applies to $r_H \geq r_L$, but if $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} > \frac{r_H}{r_L}$, the denominator of (2.17) is still higher than in the core model (part (ia)). The intuition is incomplete, because using funds to finance investment has two effects. They can be best seen by the following decomposition of the investment returns:

$$\begin{aligned} R_L &= F(1 + r_L) \\ R_H &= F(1 + r_L) + F(r_H - r_L). \end{aligned}$$

The first, intuitive effect is the $F(r_H - r_L)$ term which appears in the R_H equation only. The value of investment is greater for H , increasing information asymmetry. However, there is a second effect, captured by the $F(1 + r_L)$ term common to both firms. This term increases the certainty effect: since the investment is positive-NPV, the certain component of the firm's balance sheet is now higher: $F(1 + r_L)$ rather than F . While investors do not know firm quality, they do know that the funds they provide will increase in value, regardless of quality.¹⁴ Due to this second effect, $r_H \geq r_L$ is not sufficient for the upper bound to relax. Only if $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} < \frac{r_H}{r_L}$ does the first effect dominate, loosening the upper bound (part (ib)). Finally, if $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \leq \frac{1+r_H}{1+r_L}$, i.e., investment exhibits high information asymmetry, then the ND condition (2.17) holds for any F (part (ii)).

Another way to view the intuition is as follows. Equityholders obtain a portfolio of assets in place ($C + A$) and the new investment (R); F determines the weighting of the new investment in this portfolio. H cooperates with asset sales if his capital loss, $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]}$, is less than the weighted average loss on this overall portfolio. If both the assets in place and the new investment exhibit higher information asymmetry than non-core assets, i.e., $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \leq \frac{C_H + A_H}{C_L + A_L}$ and $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \leq \frac{1+r_H}{1+r_L}$, then the loss on the portfolio is greater regardless of the weights – hence, H cooperates regardless of F . Deviation is only possible if the investment is safer than non-core assets, i.e., $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} > \frac{1+r_H}{1+r_L}$. In this case, the weight

¹⁴Note that equity issuance does not become more likely simply because the firm is worth more due to its growth opportunities, which attracts investors. The growth opportunities are fully priced into the equity issue and are not a “freebie.”

placed on the new investment (F) must be low for the weighted average loss to remain higher for the portfolio, and so for deviation to be ruled out. Regardless of the specific values of r_H and r_L , in all cases the *APE* requires F to be below an upper bound, as in the core model.¹⁵

The analysis for *EPE* is very similar: it holds as long as r_H is sufficiently high (and so no firm deviates to no issuance), and F is above a lower bound. Similarly, *SSE* (where firms sell either assets or equity) continues to hold if r_H is sufficiently high. Moreover, we now have additional semi-separating equilibria, where some firms choose to do nothing. We defer the full analysis of these equilibria to Section 2.9, but provide the sustainability conditions and a comparison of the equilibria in Proposition 2 below.

Proposition 2. *(Positive correlation, comparison of equilibria, capital raising is a choice.)*

(i) *The equilibria of Section 2.2.1 hold under the following conditions:*

(ia) *An asset-pooling equilibrium holds under the conditions stated in Lemma 4.*

(ib) *An equity-pooling equilibrium holds if all of the following conditions are satisfied:*

(ibi) $1 + \underline{k} \geq \frac{E_L}{\mathbb{E}[E]}$, *a weaker condition than when cash remains on the balance sheet*

(Lemma 2),

(ibii) $1 + r_H \geq \frac{E_H}{\mathbb{E}[E]}$, *a new condition not in Lemma 1.*

(ibiii) $F \geq \max(F^{EPE,ND,H,I}, F^{EPE,IC,I})$, *where*

$$F^{EPE,ND,H,I} \equiv \frac{A_L(C_H + A_H) - A_H \mathbb{E}[C + A](1 + \underline{k})}{A_H(1 + \underline{k})\mathbb{E}[1 + r_q] - A_L(1 + r_H)}$$

$$F^{EPE,IC,I} \equiv \frac{A_L \mathbb{E}[C + A](1 + \underline{k}) - A_H(C_L + A_L)}{A_H(1 + r_L) - A_L \mathbb{E}[1 + r_q](1 + \underline{k})}$$

(ic) *A semi-separating equilibrium in which quality q sells assets if $k \leq k_q^*$ and issues*

¹⁵For $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \leq \frac{1+r_H}{1+r_L}$, the upper bound is infinite and therefore greater than $\min(A_H, A_L) \geq F$, making asset-pooling sustainable for any F .

equity if $k > k_q^*$, holds under the conditions of Lemma 3, plus the additional condition $1 + r_H > \frac{E_H}{E_L}$.

(ii) A semi-separating equilibrium in which H sells assets if $k \leq k_H^*$ and does nothing if $k > k_H^*$, and L sells assets if $k \leq k_L^*$ and issues equity if $k > k_L^*$, holds if $1 + r_H \leq \frac{E_H}{E_L}$. If $1 + \bar{k} < \frac{A_H}{A_L}$ then $k_H^* = \bar{k}$. If $1 + \bar{k} > \frac{E_H}{E_L}$ then $k_L^* = \bar{k}$ (and the belief that equity issuers are type L is specified off the euqilibrium path). A rise in r_H increases both k_H^* and k_L^* .

(iia) If $1 + r_H > \frac{A_H(1+\underline{k})}{A_L}$, both cutoffs are interior and defined by $1 + k_H^* = \frac{\mathbb{E}[A|X=A](1+r_H)}{A_H}$ and $1 + k_L^* = \frac{\mathbb{E}[A|X=A]}{A_L}$, where $k_L^* > 0$. If $1 + r_H > (<) \frac{A_H}{A_L}$ then $k_H^* > (<) k_L^*$. The price of assets sold is $\mathbb{E}[A|X = A] > A_L$, which exceeds $\mathbb{E}[A]$ if and only if $k_H^* > k_L^*$. The price of equity issued is $C_L + A_L + F(1 + r_L)$. As \underline{k} falls, the value of assets sold moves towards $\mathbb{E}[A]$: If $k_H^* > (<) k_L^*$ then this entails a drop (rise) in the price of assets sold.

(iib) If $1 + r_H < \frac{A_H(1+\underline{k})}{A_L}$ then $k_H^* = \underline{k}$ and $k_L^* = 0$. H -firms do nothing, L -firms with positive synergies issue equity, and L -firms with negative synergies sell assets. The price of assets is A_L and the price of equity is $C_L + A_L + F(1 + r_L)$. In particular, this equilibrium holds if firms can choose inaction but do not have valuable investment opportunities ($r_H = r_L = 0$).

Part (i) of Proposition 2 shows that the equilibria of the core model are sustainable if r_H is sufficiently high. Intuitively, H is only willing to sustain the losses from raising capital if the capital can be put to a sufficiently productive use. This part demonstrates that the core model's results continue to hold when there is information asymmetry over the use of the cash raised. It remains the case that an *APE* (*EPE*) is sustainable for low (high) F . As in the core model, the source of financing depends on the amount of financing required.

In addition to demonstrating robustness, this extension also generates a new prediction. As r_H falls and r_L rises (the information asymmetry of investment falls), the upper bound on the *APE* tightens and the lower bound on the *EPE* loosens. Thus, the source of financing also depends on the use of financing. If growth opportunities are good regardless of firm

quality (if r_L is high, for example in young firms or in good macroeconomic conditions), then they are more likely to be financed using equity. The use of financing also matters in models of moral hazard (uses subject to agency problems will be financed by debt rather than equity) or bankruptcy costs (purchases of tangible assets are more likely to be financed by debt rather than equity); here it matters in a model of pure adverse selection. In addition, our predictions for the use of equity differ from a moral hazard model. Under moral hazard, if cash is to remain on the balance sheet, equity is undesirable due to the agency costs of free cash flow (Jensen (1986)). Here, equity is preferred due to the certainty effect.

Part (iia) shows that if r_H is moderate (if $\frac{A_H(1+k)}{A_L} < 1+r_H < \frac{E_H}{E_L}$), H -firms with synergistic assets will not raise capital, since the return on investment is insufficient to outweigh the loss of synergies (plus capital loss) from selling assets or the capital loss from issuing equity. However, H -firms with dissynergistic assets will sell them: not so much to finance investment, but for operational reasons. As before, L sells either equity or assets (depending on its level of synergy), not so much to finance investment, but to exploit overvaluation. We have $k_L^* > 0$: L prefers to sell assets rather than equity, and indeed will sell assets even if they are synergistic. The reason is the *camouflage effect*. Since the growth opportunity is low, the only reason to sell equity is if it is low-quality. No H -firms sell equity, and so equity issuance reveals the firm as L and leads to a price of E_L . In contrast, asset sales may be undertaken either because the asset is low-quality (low common value, sold by L) or because it is dissynergistic (low private value, sold by H), and so the asset price exceeds A_L . This high price induces L to sell assets ($k_L^* > 0$). Markets in which H sells assets due to negative k are deep, similar to the notion of “market depth” in Kyle (1985). The liquidity traders in Kyle (1985) are analogous to high-quality asset sellers: they are selling assets for reasons other than them having a low common value. The presence of such traders allows informed speculators, who do have assets with a low common value, to profit by selling them.

Note that, for any semi-separating equilibrium, there may be said to be “camouflage” in that

multiple types pool into the same action. We define the camouflage effect quite specifically, as an economic concept focused on the choice between asset sales and equity issuance, rather than the technical concept of multiple types pooling, which occurs in any semi-separating equilibrium. Specifically, the camouflage effect arises when low-quality firms are willing to sell assets, even if they are synergistic (formally, $k_L^* > 0$), because asset sales can be disguised as being motivated by operational reasons and thus fetch a high price. This disguise arises because, while both asset sales and equity issuance can arise from the operational reason of wishing to exploit a growth opportunity, asset sales have the additional operational reason of being motivated by synergies. As a result, when growth opportunities are moderate, high-quality firms will only voluntarily sell assets, not equity, and so low-quality firms also prefer to sell assets. In contrast, we do not claim that the semi-separating equilibria of Lemma 3 exhibit a camouflage effect: even though multiple firm types pool on the same action, this is similar to any semi-separating equilibrium and does not arise from H voluntarily selling assets due to operational reasons. Capital raising is mandatory, and so even when H prefers to sell assets ($k_H^* > 0$), it is because assets exhibit less informational asymmetry than equity rather than when assets being dissynergistic.

Just like the certainty effect, the camouflage effect in our paper also applies to the choice between asset sales and risky debt. In the absence of a profitable growth opportunity, the issue of risky debt signals that the debt is overvalued, since it cannot be camouflaged as stemming from an operational reason, unlike an asset sale.

The *SSE* in part (ic), where all firms sell either assets or equity, exhibits greater real efficiency than the one in part (iia) since all firms are undertaking profitable investment. It is easier to satisfy the condition for part (ic) ($1 + r_H > \frac{E_H}{E_L}$), and harder to satisfy the condition for part (iia) ($1 + r_H \leq \frac{E_H}{E_L}$), if F is high. Thus, a greater *scale* of investment opportunities (high F) encourages H to invest, even if the per-unit productivity of investment (r_H) is unchanged. The certainty effect reduces the per-unit cost of financing, whereas nonlinearities typically considered in the literature (e.g., limited supply of capital) increase the per-unit

cost of financing. Thus, a higher F has beneficial real consequences by allowing firms to take profitable investment opportunities.

Part (iib) shows that if r_H is low (if $1 + r_H < \frac{A_H(1+\underline{k})}{A_L}$), even H -firms with the most dissynergistic assets do nothing. Information asymmetry $\frac{A_H}{A_L}$ is so strong that the capital loss from asset sales is high relative to the growth opportunity r and the dissynergy motive \underline{k} . Since no H -firms sell assets, asset sales do not offer camouflage. Thus, $k_L^* = 0$: L -firms will only sell assets if and only if they are dissynergistic, not to enjoy a camouflage effect. In sum, the camouflage effect only exists within the range $\frac{E_H}{E_L} \geq 1 + r_H > \frac{A_H(1+\underline{k})}{A_L}$, and this range only exists if \underline{k} is sufficiently low to motivate H -firms to sell assets.

Part (iii) shows that, if $r = 0$, even L has no reason to issue equity: it cannot exploit overvaluation since there is no camouflage, and it is unable to invest the cash raised profitably. Thus, low-quality firms with sufficiently synergistic assets ($k > k_L^*$) are indifferent between selling equity and doing nothing. Indeed, there exists an equilibrium where all L -firms with $k > k_L^*$ do nothing, and so the equity market shuts down. Absent an investment opportunity, the only reason to sell equity is if it is low-quality, and so the “no-trade” theorem applies. In contrast, asset sales may be motivated by operational reasons and so the market continues to function.

Comparing across the three parts of Proposition 2, when the investment opportunity is non-existent ($r_H = r_L = 0$), the equity market can completely shut down, as in Myers and Majluf (1984). When r_H is moderate (parts (ia) and (ib)), only low-quality firms issue equity; only when it is high (part (ic)) do firms of both quality issue equity. Thus, increases in r_H encourage equity issuance. Investment opportunities allow L to camouflage its issuance of equity as being motivated by operational reasons (the desire to finance growth). Without growth opportunities, only asset sales can be justified by operational reasons and thus offer camouflage.

2.3. Negative Correlation

We now turn to the case of negative correlation, i.e., $A_L > A_H$. This section demonstrates the *correlation effect*: firms prefer asset sales to equity issuance, because even if the market infers that the asset sold is low-quality, this need not imply that the firm as a whole is of low quality, since it is not a carbon copy of the asset.

Since $A_L > A_H$, we now use the term “high (low)-quality non-core assets” to refer to the non-core assets of L (H). Note that negative correlation only means that high-quality firms are not universally high-quality, as they may have low-quality non-core assets. It does not require the values of the divisions to covary negatively with each other (e.g., that a market upswing helps one division and hurts the other). The market may know the correlation of the asset with the core business (even if it does not observe quality) simply by observing the type of asset traded. For example, the value of BP’s exploration activities is likely to be negatively correlated with the mature fields that comprise the bulk of the firm, since the former may displace the latter.

In this section, we return to the case of general stock price concerns ω because, with negative correlation, there is now a trade-off involved in selling assets: being inferred as H maximizes the firm’s stock price, but being inferred as L maximizes sale proceeds and thus fundamental value. Thus, without stock price concerns, no pooling equilibrium is sustainable. Since neither investment opportunities r_q nor synergies k affect the sustainability of any equilibria, but just add additional terms to the expressions, we return to the core model where the funds raised remain on the balance sheet, and for simplicity consider the case of no synergies ($\underline{k} = \bar{k} = 0$).

We start by deriving the conditions under which a separating equilibrium (SE) exists, then turn to the two pooling equilibria APE and EPE . (Without synergies, there are only two firm types (H and L), and so we have separating equilibria rather than semi-separating equilibria as in Section 2.2.1.3.)

2.3.1. Separating Equilibrium

We consider a separating equilibrium in which H sells assets and L issues equity.¹⁶ Lemma 5 gives the conditions for this equilibrium to be satisfied:

Lemma 5. *(Negative correlation, separating equilibrium.) Consider a separating equilibrium in which H sells assets and L sells equity ($X_H = A$, $X_L = E$). The prices of assets are given by A_H and $C_L + A_L + F$, respectively. The stock prices of asset sellers and equity issuers are $C_H + A_H$ and $C_L + A_L$, respectively. This equilibrium is sustainable if*

$$\omega \leq \omega^{SE} \equiv \frac{\frac{F(A_L - A_H)}{A_H}}{\frac{F(A_L - A_H)}{A_H} + (C_H - C_L) - (A_L - A_H)}. \quad (2.18)$$

Since both assets and equity are sold at their fair price, there are no capital gains or losses.

If L deviates, his fundamental value will fall from $C_L + A_L$ to

$$C_L + A_L + \frac{F(A_H - A_L)}{A_H}.$$

Crucially, the third term is negative, since $A_L > A_H$: L suffers a capital loss, which offsets the fact that his market value rises from being inferred as H . Thus, he will not deviate only if his stock price concerns ω are sufficiently low (i.e., satisfy (2.18)).

H will not deviate as his stock price will fall to $C_L + A_L$, and his fundamental value will fall as he will be issuing underpriced equity rather than selling a fairly-priced asset. H 's assets are correctly assessed as “lemons,” and so the market timing motive for financing (e.g., Baker and Wurgler (2002)) does not exist. However, H is still willing to sell assets despite receiving a low price. Since the assets being sold are not perfectly correlated with the rest of the firm, their low price does not imply a low value for the firm. This *correlation effect* is absent in a standard model of security issuance, because both debt and equity are positively

¹⁶There is no “reverse” separating equilibrium where H issues equity and L sells assets, because L will deviate: he will enjoy a capital gain from selling lowly-valued equity at a high price, and also an increase in his market value.

correlated with firm value. The issuance of debt may imply that debt is low-quality, and so the remainder of the firm is also low-quality.

The upper bound ω^{SE} is increasing in F – but the role of F is different from in Section 2.2. The certainty effect is not relevant in SE , as equity is issued at a fair price, rather than a pooled price. Here, a greater F means that, if L deviates to selling assets, his capital loss is sustained over a larger base, deterring deviation: the “base effect”. Thus, the SE can be sustained with higher stock price concerns ω .¹⁷

2.3.2. Pooling Equilibrium, All Firms Sell Assets

As in Section 2.2.1.1, we consider an APE , supported by the OEPB that an equity issuer is of quality L . Lemma 6 gives the conditions for this equilibrium to be satisfied:

Lemma 6. *(Negative correlation, pooling equilibrium, all firms sell assets.) Consider a pooling equilibrium where all firms sell assets ($X_H = X_L = A$) and a firm that sells equity is inferred as L . The prices of assets and equity are $\pi A_H + (1 - \pi)A_L$ and $C_L + A_L + F$, respectively. The stock prices of asset sellers and equity issuers are $\mathbb{E}[C + A]$ and $C_L + A_L$, respectively. This equilibrium is sustainable if*

$$\omega \geq \omega^{APE} \equiv \omega^{APE,ND} \equiv \frac{F \left(\frac{A_L}{\mathbb{E}[A]} - 1 \right)}{\pi((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{\mathbb{E}[A]} - 1 \right)}. \quad (2.19)$$

H will not deviate, as he is making a capital gain from selling low-quality assets. By deviating, L avoids the capital loss from selling highly-valued assets at a pooled price, but suffers a low stock price. Thus, he will only cooperate if his concern for the stock price ω is high, i.e., satisfies equation (2.19). This lower bound is relatively loose: it is easy to rule out a deviation to equity. Issuing equity not only leads to a low price (of $C_L + A_L + F$)

¹⁷This separating equilibrium is also featured in Nanda and Narayanan (1999), where core and non-core assets are always negatively correlated and $\omega = 0$. (If assets are positively correlated, there is no information asymmetry in their model.) Thus, no pooling equilibria are sustainable in the absence of transactions costs. They assume that the transactions costs of asset sales are higher than for equity issuance, which sometimes supports an EPE but never an APE : the opposite result to our paper.

on the equity being sold (as in Myers and Majluf (1984)), but also implies a low valuation (of $C_L + A_L$) for the rest of the firm, because the equity being sold is a carbon copy of the firm. The second effect is absent in Myers and Majluf (1984), since the manager only cares about fundamental value and not the stock price.

The bound is increasing in F , so again the amount of financing required affects the choice of financing and thus firm boundaries. As in Section 2.3.1, F operates here through the base effect: higher F means that L 's capital loss is off a higher base and increases his incentive to deviate, and so a higher ω is required to maintain indifference. The IC condition is trivially satisfied. L will indeed deviate to equity if revealed H : his stock price will rise and he will receive a capital gain by selling equity for a high price (compared to his current loss on assets).

2.3.3. Pooling Equilibrium, All Firms Sell Equity

We finally consider an *EPE*, supported by the OEPB that an asset seller is of quality L . Lemma 7 gives the conditions for this equilibrium to be satisfied:

Lemma 7. *(Negative correlation, pooling equilibrium, all firms sell equity.) Consider a pooling equilibrium where all firms sell equity ($X_H = X_L = E$) and a firm that sells assets is inferred as L . The prices of assets and equity are given by A_L and $\pi(C_H + A_H) + (1 - \pi)(C_L + A_L) + F$, respectively. The stock prices of asset sellers and equity issuers are $C_L + A_L$ and $\mathbb{E}[C + A]$, respectively. This equilibrium is sustainable if*

$$\omega \geq \omega^{EPE} \equiv \omega^{EPE,IC} \equiv \frac{F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}{(1 - \pi)((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}. \quad (2.20)$$

L will automatically not deviate as he is enjoying a capital gain by selling low-quality equity at a pooled price. By deviating, H avoids the capital loss from equity but suffers a low

stock price from being inferred as L . He will cooperate if:

$$\omega \geq \omega^{EPE,ND} \equiv \frac{F\left(\frac{E_H}{\mathbb{E}[E]} - \frac{A_H}{A_L}\right)}{\pi((C_H - C_L) - (A_L - A_H)) + F\left(\frac{E_H}{\mathbb{E}[E]} - \frac{A_H}{A_L}\right)}. \quad (2.21)$$

Compared with (2.19) (the ND condition in the APE), the EPE condition in (2.21) is harder to satisfy. In the APE , deviation to equity leads to a low price of $C_L + A_L$ not only on the equity sold, but also on the rest of the firm. Here, deviation to assets leads to a low price of $C_L + A_L$ on the firm, but a high price of A_L on the asset sold, since it is not a carbon copy.

Unlike in Section 2.3.2, the IC condition is non-trivial, since L would suffer a capital loss if he deviated to asset sales and was inferred as H . The IC condition (equation (2.20)) is stronger than the ND condition. If it is violated, the only “reasonable” OEPB is that an asset seller is of quality H . Under this OEPB, while deviation to asset sales leads to a low asset price of A_H , as the market correctly infers that they are “lemons”, it does not imply a low price on the rest of the firm, which is valued at $C_H + A_H$: the correlation effect. H will now deviate, as it will break even on the asset sale (compared to its current loss from issuing equity), and also receive a high stock price (compared to its current pooled stock price).

2.3.4. Comparing the Pooling Equilibria

We now analyze conditions under which each equilibrium is sustainable. The results are given in Proposition 3 below:

Proposition 3. *(Negative correlation, comparison of equilibria.) A separating equilibrium is sustainable if $\omega \leq \omega^{SE}$, an asset-pooling equilibrium is sustainable if $\omega \geq \omega^{APE}$, and an equity-pooling equilibrium is sustainable if $\omega \geq \omega^{EPE}$, where ω^{SE} , ω^{APE} , and ω^{EPE} are given by (2.18), (2.19), and (2.20), respectively and $\omega^{APE} < \omega^{SE} < \omega^{EPE}$. Thus, if:*

(i) $0 < \omega < \omega^{APE}$, only the separating equilibrium is sustainable,

(ii) $\omega^{APE} \leq \omega \leq \omega^{SE}$, both the separating and asset-pooling equilibria are sustainable,

(iii) $\omega^{SE} < \omega < \omega^{EPE}$, only the asset-pooling equilibrium is sustainable,

(iv) $\omega^{EPE} \leq \omega < 1$, both the asset-pooling and equity-pooling equilibria are sustainable.

The correlation effect encourages firms to sell assets, which in turn manifests in two ways in Proposition 3. First, a separating equilibrium is sustainable, whereas it was unattainable in the positive correlation model without synergies. Second, the range of ω 's over which the *EPE* is sustainable is a strict subset of that over which the *APE* is sustainable. Asset sales are more common than equity issuance, even though assets may exhibit greater information asymmetry than equity. If $\frac{A_L}{A_H} > \frac{C_H + A_H}{C_L + A_L}$, the Myers and Majluf (1984) principle would suggest that equity should be preferred, but assets are preferred due to the correlation effect.

The preference for asset sales points to an interesting benefit of diversification. Stein (1997) notes that an advantage of holding assets that are not perfectly correlated is “winner-picking”: a conglomerate can increase investment in the division with the best investment opportunities at the time. Our model suggests that another advantage is “loser-picking”: a firm can raise finance by selling a low-quality asset, without implying a low value for the rest of the firm. Non-core assets are a form of financial slack and may be preferable to debt capacity. Debt is typically positively correlated with firm value, and so a debt issue may lead the market to infer that both the debt being sold and the remainder of the firm are low-quality. (Cash remains the best form of slack.)

The analysis also points to a new notion of investment reversibility. Standard theories (e.g., Abel and Eberly (1996)) model reversibility as the real value that can be salvaged by undoing an investment, which in turn depends on the asset's technology. Here, reversibility depends on the market's inference of firm quality if an investment is sold, and thus the correlation between the asset and the rest of the firm.

Section 2.7 considers the case when the firm can sell the core asset. Since the core (non-core) asset is positively (negatively) correlated with firm value, this extension allows the firm to choose the correlation of the asset that it sells, whereas the analysis thus far has considered either positive or negative correlation. Section 2.7 shows that a pooling equilibrium in which all firms sell the non-core asset is easier to sustain than one in which all firms sell equity, and one in which all firms sell the core asset. This is because the non-core asset is negatively correlated with firm value, whereas equity and the core asset are both positively correlated. Thus, the correlation effect continues to apply when firms can choose the correlation of the assets they sell.

2.4. Implications

This section briefly discusses the main implications of the model. While a subset is consistent with existing stylized facts, these facts are not sharp tests of the model, given the scarcity of existing theories on the choice between asset sales and equity issuance. For the same reason, most of the empirical predictions are new and untested, and would be interesting to study in future research. In addition, the model generates other implications that may not be immediately linkable to an empirical test due to the difficulties for an empiricist to observe variables such as synergies. However, even in these cases, the model provides implications for managers when choosing how to raise capital, as they will be able to estimate synergies. Note that empirical analysis should focus on asset sales that are primarily financing-motivated.

The first set of empirical implications concerns the determinants of financing choice. One determinant is the amount of financing required: Proposition 1 shows that equity is preferred for high financing needs, due to the certainty effect, while asset sales are preferred for low financing needs. For example, large oil and gas companies typically expand by adding individual fields, which require low F ; indeed, this industry exhibits an active market for asset sales.

A related implication is that equity issuances should be larger on average than financing-motivated asset sales. The link between the source of financing and the amount required will be stronger where there is less scope for synergies. With low synergies, only pooling equilibria are sustainable, and so when F is high (low), all firms sell equity (assets). With high synergies, we have a semi-separating equilibrium, and so even when F is high (low), some firms are selling assets (equity). Separately, with low synergies, firms will issue the same type of claim for a given financing requirement; with high synergies, we should observe greater heterogeneity across firms in financing choices. Estimating the potential for (dis)synergies is difficult. One potential route is to look across the business cycle: Eisfeldt and Rampini (2006) argue that operational motives are stronger in booms. An alternative direction is to compare across industries. For example, in the oil and gas industry, asset sales frequently involve self-contained plants with little scope for synergies. In consumer-facing industries with the potential for cross-selling multiple products to the same customer base, operational motives should be stronger.

A second determinant of financing choice is the use of funds. Both the certainty and camouflage effects predict that equity issuance is increasing in growth opportunities. Starting with the former, Proposition 2 shows that the certainty effect is stronger when financing an investment opportunity that is attractive regardless of firm quality (r_L is high). Moving to the latter, Proposition 2 also shows that, if growth opportunities are low, only asset sales can provide camouflage, since high-quality firms have operational reasons to sell assets but not to issue equity. If growth opportunities are high, equity also provides camouflage. Not only do high-quality firms start to issue equity to take advantage of the growth opportunity, but low-quality firms issue equity to a greater extent, as they can pool with high-quality equity issuers. Both effects predict that, along the cross-section, firms with good investment opportunities should raise equity, as documented by Frank and Goyal (2003) and Fama and French (2005). Over the time series, in a strong macroeconomic environment, even low-quality firms will have good investment projects and so the model predicts that equity is again preferred, as found by Choe et al. (1993). Covas and den Haan (2011) show that

equity issuance is procyclical, except for the very largest firms. A separate prediction from the certainty effect is that equity is more likely to be used for purposes with less information asymmetry, such as paying debt or distress.

A third determinant of financing choice is firm characteristics. Single-segment firms are more likely to issue equity; firms with negatively-correlated assets prefer asset sales due to the correlation effect. Thus, conglomerates are more likely to sell assets than firms with closely-related divisions, and more likely to sell non-core assets than core assets (see Section 2.7). Indeed, Maksimovic and Phillips (2001) find that conglomerates are more likely to sell peripheral divisions rather than main divisions. While consistent with the correlation effect, this result could also stem from operational reasons: peripheral divisions could be more likely to be dissynergistic. Maksimovic and Phillips (2001) also find that less productive divisions are more likely to be sold. This result is consistent with the idea that conglomerates can sell poorly-performing divisions without creating negative inferences on the rest of the firm, although they do not study the market reaction to such sales.

A second set of empirical implications concerns the market reaction to financing. In the negative correlation case, and in the positive correlation case with synergies where $k_H^* > k_L^*$ (which arises under low F), asset sales lead to a positive stock price reaction and equity issuance leads to a negative stock price reaction. Indeed, Jain (1985), Klein (1986), Hite et al. (1987), and Slovin et al. (1995), among others, find evidence of the former; a long line of empirical research beginning with Asquith and Mullins (1986) documents the latter. Under positive correlation and high F , we have $k_L^* > k_H^*$, and so equity issuance leads to a positive reaction. While most existing theories do not predict a positive reaction to equity issuance, Holderness (2013) finds a positive reaction in some countries. However, it is not clear whether these correspond to the cases in the model as he does not study the size of the equity issue or the correlation structure of the issuer. Separately, the model also predicts that equity issuance for conglomerates (where negative correlation is likely) will typically lead to a more negative reaction than for single-segment firms.

We now move to implications that may be less readily testable. Firms are more willing to sell assets in deep markets where others are selling for operational reasons, providing camouflage. This prediction is harder to test because it is difficult to identify the actual motive for a given sale. A more general implication is that there will be multiplier effects: economic conditions that increase operational motives for asset sales will also increase overvaluation-motivated asset sales. Eisfeldt and Rampini (2006) present a model showing that operational motives for asset sales are procyclical, and empirically find that asset sales are indeed procyclical. This procyclicality may arise not only because operational motives rise in booms, but also because L is able to camouflage asset sales as being operationally-motivated in booms (see Proposition 2, part (iia)).

The model's implications regarding synergies are also harder to test given the difficulty in estimating synergies. Equity issuers are likely to have synergistic assets, and asset sellers are likely to be parting with dissynergistic ones. Moreover, high-quality firms are more likely to sell synergistic assets if their financing needs are low, whereas low-quality firms are more likely to do so if their financing needs are high.

2.5. Conclusion

This paper has studied a firm's choice between financing through asset sales and equity issuance under asymmetric information. A direct extension of Myers and Majluf (1984) would imply that firms will issue the claim that exhibits the least information asymmetry. While information asymmetry is indeed relevant, we identify three new forces that drive the firm's financing decision, and may outweigh information asymmetry considerations.

First, investors in an equity issue share in the cash raised, but purchasers of non-core assets do not. Since the value of cash is certain, it mitigates the information asymmetry of equity: the certainty effect. Thus, low (high) financing needs are met through asset (equity) sales: the amount of financing required affects the choice of financing, and consequently firm boundaries. This result is robust to using the cash to finance an uncertain investment.

Second, the choice of financing may also depend on operational motives (synergies). A higher financing need pushes high-quality firms towards equity, due to the certainty effect, and reduces the quality and price of assets sold. Synergy concerns also allow firms to disguise an asset sale, that is in reality motivated by the asset's low quality, as instead being motivated by operational reasons (dissynergies): the camouflage effect.

Third, a disadvantage of equity issuance is that the market attaches a low valuation not only to the equity being sold, but also to the remainder of the firm, since both are perfectly correlated. In contrast, an asset sold need not be a carbon copy of the firm. This correlation effect can lead to asset sales being strictly preferred to equity.

In sum, our model predicts that equity issuance is preferred when the amount of financing required is high, if growth opportunities are good, and for uses about which there is little information asymmetry (e.g., repaying debt). Asset sales are preferred if the firm has non-core assets that exhibit little information asymmetry or are dissynergistic, if other firms are currently selling assets for operational reasons, if the firm is a conglomerate, and if a firm's financing needs are privately known.

The paper suggests a number of avenues for future research. On the empirical side, it gives rise to a number of new predictions, particularly relating to the amount of financing required and the purpose for which funds are raised. On the theoretical side, a number of extensions are possible. One would be to allow for other sources of asset-level capital raising, such as equity carve-outs. Since issuing asset-level debt or equity does not involve a loss of (dis)synergies, a carve-out is equivalent to asset sales in the core model where synergies are zero, but it would be interesting to analyze the case in which synergies are non-zero and the firm has a choice between asset sales, carve-outs, and equity issuance. Another restriction of the model is that, even where firms can choose whether to raise capital, they raise a fixed amount F (as in Myers and Majluf (1984) and Nachman and Noe (1994)), since there is a single investment opportunity with a known scale of F . An additional extension would be to allow for multiple investment opportunities of different scale, in which case a continuum

of amounts will be raised in equilibrium.

2.6. Proofs

Proof of Lemma 1

The IC condition (2.9) is stronger than the ND condition (2.7) if and only if

$$\frac{A_L(C_H + A_H)(1 + \bar{k}) - \mathbb{E}[A](C_L + A_L)}{\mathbb{E}[A] - A_L(1 + \bar{k})} < \frac{(C_H + A_H)\mathbb{E}[A] - (C_L + A_L)A_H(1 + \bar{k})}{A_H(1 + \bar{k}) - \mathbb{E}[A]}$$

This yields $1 + \bar{k} < \frac{\mathbb{E}[A]}{\sqrt{A_H A_L}}$. Note that the RHS is always greater than one since $\pi > \frac{1}{2}$.

Proof of Lemma 2

$F^{EPE, IC}$ is greater than $F^{EPE, ND, H}$ if and only if

$$\frac{A_L\mathbb{E}[C + A](1 + \underline{k}) - A_H(C_L + A_L)}{A_H - A_L(1 + \underline{k})} > \frac{A_L(C_H + A_H) - A_H\mathbb{E}[C + A](1 + \underline{k})}{A_H(1 + \underline{k}) - A_L}$$

which becomes

$$1 + \underline{k} > \frac{A_H A_L}{\pi A_H^2 + (1 - \pi) A_L^2} = \frac{A_H A_L}{\mathbb{E}[A^2]}.$$

The RHS is always less than 1 since $\pi > \frac{1}{2}$.

Proof of Lemma 3

While investors do not directly care about k (as it only affects private values), the synergy cutoffs affect the expected quality (common value) of the claims. The prices of assets and equity in equations (2.13) and (2.14) are given by Bayes' rule.

A type (q, k) will prefer equity if and only if its unit cost of financing is no greater:

$$\frac{C_q + A_q + F}{\mathbb{E}[E|X = E]} \leq \frac{A_q(1 + k)}{\mathbb{E}[A|X = A]}. \quad (2.22)$$

The cutoff k_q^* is that which allows (2.22) to hold with equality. Thus, it is defined by:

$$1 + k_q^* = \frac{C_q + A_q + F}{A_q} \frac{\mathbb{E}[A|X = A]}{\mathbb{E}[E|X = E]}. \quad (2.23)$$

Although k_q^* is not attainable in closed form, we can study whether $k_H^* \leq k_L^*$. Since only the $\frac{C_q + A_q + F}{A_q}$ term on the RHS depends on q , the higher cutoff k_q^* belongs to the quality q for which this term is higher. Thus, $k_H^* > k_L^*$ if and only if

$$\frac{C_H + A_H + F}{C_L + A_L + F} > \frac{A_H}{A_L} \quad (2.24)$$

i.e.,

$$F < F^* \equiv \frac{C_H A_L - C_L A_H}{A_H - A_L}. \quad (2.25)$$

From the cutoff equation (2.23), we also have

$$\frac{A_L(1 + k_L^*)}{E_L} = \frac{A_H(1 + k_H^*)}{E_H} = \frac{\mathbb{E}[A|X = A]}{\mathbb{E}[E|X = E]}.$$

These equations mean that, in any SE , k_L^* and k_H^* obey the following relationship:

$$1 + k_H^* = \lambda(F) (1 + k_L^*), \quad (2.26)$$

where $\lambda(F) \equiv \frac{A_L}{A_H} \frac{E_H}{E_L}$, which is decreasing in F . If $F < (>) F^*$, then $\lambda > (<) 1$ so $k_H^* > (<) k_L^*$ from (2.26).

Due to the certainty effect, changes in F alter the cutoffs and thus the quality of assets and equity sold, in turn affecting their prices. If $F > F^*$, (2.24) is violated: the certainty effect is sufficiently strong that equity is more attractive to H ($k_H^* < k_L^*$). More H firms sell equity, increasing (decreasing) the quality and price of equity (assets) sold. Indeed, when $F > F^*$, we have $k_H^* < 0$: H retains assets even if they are mildly dissynergistic, due to their higher information asymmetry. Now, the equity price (2.14) is higher than in the EPE (2.11).

Thus, as in the model without synergies, increases in F have real effects on firm boundaries. Here, they lead to more H -firms retaining assets, even if they are dissynergistic.

These general results hold regardless of whether the cutoffs k_q^* are interior or are at the boundaries \bar{k} or \underline{k} . However, to prove existence of any of these equilibria, we must formally deal separately with the cases where cutoffs are interior or are at the boundaries. Results are summarized in the following Lemma.

Lemma 8. *A full semi-separating equilibrium where both qualities q strictly separate ($\underline{k} < k_q^* < \bar{k}$) is sustainable under the following conditions:*

(ia) *If $F < F^*$, a necessary condition is $1 + \bar{k} > \frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$ and a sufficient condition is $1 + \bar{k} \geq \frac{E_H}{E_L}$.*

(ib) *If $F > F^*$, a necessary condition is $1 + \underline{k} < \frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$ and a sufficient condition is $1 + \underline{k} \leq \frac{A_L}{A_H}$.*

(ic) *If $F = F^*$, this is sufficient for existence.*

A partial semi-separating equilibrium where H 's cutoff is at a boundary is sustainable in the following cases:

(iia) *If $F < F^*$, we can sustain a SSE where all H -firms sell assets ($k_H^* = \bar{k}$) and L -firms strictly separate ($\underline{k} < k_L^* < \bar{k}$), where $k_L^* > 0$. A necessary condition is $\frac{\mathbb{E}[A]}{A_L} < 1 + \bar{k} < \frac{E_H}{E_L}$ and a sufficient condition is $\frac{A_H}{A_L} \leq 1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_H} \frac{E_H}{E_L}$.*

(iib) *If $F > F^*$, we can sustain a SSE where all H -firms sell equity ($k_H^* = \underline{k}$) and L -firms strictly separate ($\underline{k} < k_L^* < \bar{k}$), where $k_L^* < 0$. A necessary condition is $\frac{A_L}{A_H} < 1 + \underline{k} < \frac{E_L}{\mathbb{E}[E]}$ and a sufficient condition is $\frac{A_L}{A_H} \frac{E_H}{\mathbb{E}[E]} \leq 1 + \underline{k} \leq \frac{E_L}{E_H}$.*

A partial semi-separating equilibrium where L 's cutoff is at a boundary is sustainable in the following cases:

(iia) *If $F < F^*$, we can sustain a SSE where all L -firms sell equity ($k_L^* = \underline{k}$) and H -firms*

strictly separate ($\underline{k} < k_H^* < \bar{k}$). A set of sufficient conditions is $\underline{k} = 0$, $1 + \bar{k} > \frac{E_H}{E_L}$, and π sufficiently close to 1.

(iiib) If $F < F^*$, we can sustain a SSE where all L -firms sell assets ($k_L^* = \bar{k}$) and H -firms strictly separate ($\underline{k} < k_H^* < \bar{k}$). A set of sufficient conditions is $\bar{k} = 0$, $1 + \underline{k} < \frac{A_L}{A_H}$, and π sufficiently close to 1.

If F is close to F^* and \bar{k} or \underline{k} is extreme, synergy motives are strong, and so firms of the same quality issue different claims depending on k . We thus have a full SSE, where firms of both quality separate. In the intermediate case, where synergies are moderate relative to information asymmetry, we have a partial SSE where all firms of one quality issue the same claim, regardless of k , and firms of the other quality strictly separate.

We first derive sufficient conditions under which full SSE exists (cases (ia), (ib), and (ic) of Lemma 8). Our general proof strategy is to show existence of a pair of cutoffs (k_H^*, k_L^*) such that neither H nor L has an incentive to deviate, and such that both cutoffs are strictly between \underline{k} and \bar{k} . We start by observing that, given any k_L^* , the corresponding k_H^* in any equilibrium must be given by (2.26) above. The problem therefore reduces to proving the existence of a $k_L^* \in (\underline{k}, \bar{k})$ such that L has no incentive to deviate, and such that the corresponding k_H^* is also in (\underline{k}, \bar{k}) .

In each case, our proof technique will apply the Intermediate Value Theorem (“IVT”). This will prove the existence of a k_L^* such that L has no incentive to deviate, but will not deliver the actual value of that k_L^* , so the condition $k_H^*(k_L^*) \in (\underline{k}, \bar{k})$ cannot be checked explicitly. Instead, we will provide necessary and sufficient conditions for k_H^* to be interior regardless of the value of k_L^* . These are the conditions we state in the Lemma. For each case, we provide the necessary and sufficient conditions first, then prove the existence of k_L^* .

We start with part (ia), where $F < F^*$. The ND condition for (H, k_H^*) is $1 + k_H^* = \frac{E_H}{A_H} \frac{\mathbb{E}[A|X=A]}{\mathbb{E}[E|X=E]}$. Given a pair of cutoff rules k_H^* and k_L^* , and associated valuations $\mathbb{E}[A|X=A]$ and $\mathbb{E}[E|X=E]$, for some H -firms to be willing to issue equity (so that k_H^* is interior), we

must have

$$1 + \bar{k} > \frac{E_H}{A_H} \frac{\mathbb{E}[A|X=A]}{\mathbb{E}[E|X=E]}. \quad (2.27)$$

The RHS is bounded below by $\frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$ and above by $\frac{E_H}{E_L}$. Thus, a sufficient condition for some H -firms to issue equity is $1 + \bar{k} \geq \frac{E_H}{E_L}$ and a necessary condition is $1 + \bar{k} > \frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$. These quantities no longer depend on k_L^* since they contain no conditional expectations. Now, given that $k_H^*(k_L^*) \in (k, \bar{k})$ for any k_L^* , we demonstrate the existence of an equilibrium cutoff k_L^* . For a candidate cutoff k'_L , the indifference condition for (L, k'_L) is

$$1 + k'_L = \frac{E_L}{A_L} \frac{\mathbb{E}[A|X=A]}{\mathbb{E}[E|X=E]}. \quad (2.28)$$

Using this, we can rewrite the incentive of (L, k'_L) to sell assets rather than issue equity as a function continuous in k'_L :

$$f(k'_L) \equiv \frac{E_L}{\mathbb{E}[E|X=E]} - \frac{A_L(1 + k'_L)}{\mathbb{E}[A|X=A]}.$$

If $f(k'_L) > (<) 0$, (L, k'_L) will sell assets (equity). Thus, k'_L is an equilibrium cutoff if and only if $f(k'_L) = 0$. We show that (L, k'_L) sells assets if $1 + k'_L = \frac{E_L}{A_L} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$, and equity if $1 + k'_L = \frac{1+\bar{k}}{\lambda(F)}$. (The latter yields the highest possible k'_L , since k'_L and k'_H are related by (2.26), and k'_H is capped at \bar{k} .) Then, by the IVT, there exists a k_L^* between these two values of k'_L for which $f(k_L^*) = 0$ and so the firm is indifferent. (Note that f is everywhere defined and continuous on the interval $[k, \bar{k}]$.)

To show that (L, k'_L) sells assets if $1 + k'_L = \frac{E_L}{A_L} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$, we use the fact that $F < F^*$ implies $\lambda(F) > 1$ and so $k'_H > k'_L$. We thus have $\mathbb{E}[A|X=A] > \mathbb{E}[A]$ and $\mathbb{E}[E|X=E] < \mathbb{E}[E]$, which yields $f(k'_L) > 0$. Similarly, $1 + k'_L = \frac{1+\bar{k}}{\lambda(F)}$ yields

$$f(k'_L) = \frac{E_L}{\mathbb{E}[E|X=E]} - \frac{A_H(1 + \bar{k})}{\mathbb{E}[A|X=A]} \frac{E_L}{E_H},$$

and so $f(k'_L) < 0$ holds if and only if $1 + \bar{k} > \frac{E_H}{A_H} \frac{\mathbb{E}[A|X=A]}{\mathbb{E}[E|X=E]}$, which is the same condition as

(2.27). Thus, the sufficient condition for H to follow an interior cutoff, $1 + \bar{k} \geq \frac{E_H}{E_L}$, is also sufficient for the IVT to imply an equilibrium k_L^* , and so is sufficient for the SE to exist.

The analysis for part (ib) ($F > F^*$) is analogous. The ND condition is now

$$1 + \underline{k} < \frac{E_H}{A_H} \frac{\mathbb{E}[A|X=A]}{\mathbb{E}[E|X=E]}. \quad (2.29)$$

With $F > F^*$ we now have $\mathbb{E}[A] > \mathbb{E}[A|X=A]$ and $\mathbb{E}[E] < \mathbb{E}[E|X=E]$, so the RHS of (2.29) is bounded *above* by $\frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$. Thus, a sufficient condition for some H -firms to sell assets is $1 + \underline{k} \leq \frac{A_L}{A_H}$ and a necessary condition is $1 + \underline{k} < \frac{E_H}{A_H} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$.

We now turn to the ND condition for (L, k_L^*) , which remains (2.28), and again use the IVT. We can easily show that (L, k'_L) will deviate to equity at $1 + k'_L = \frac{E_L}{A_L} \frac{\mathbb{E}[A]}{\mathbb{E}[E]}$. A sufficient condition for (L, k'_L) to deviate to asset sales at $1 + k'_L = \frac{1+k}{\lambda(F)}$ is $1 + \underline{k} \leq \frac{A_L}{A_H}$, which is the same as the sufficient condition for some H -firms to sell assets, and so is sufficient for the SE to exist.

We finally turn to partial SSE . In case (iia), all H -firms sell assets and L -firms choose an interior cutoff. Assets are priced at $\mathbb{E}[A|X=A] > \mathbb{E}[A]$ and equity is priced at E_L . The ND condition for H -firms is:

$$1 + \bar{k} \leq \frac{\mathbb{E}[A|X=A]}{A_H} \frac{E_H}{E_L} = \lambda(F) \frac{\mathbb{E}[A|X=A]}{A_L}. \quad (2.30)$$

A sufficient condition for (2.30) is $1 + \bar{k} \leq \frac{E_H}{E_L} \frac{\mathbb{E}[A]}{A_H}$ and a necessary condition is $1 + \bar{k} < \frac{E_H}{E_L}$.

The indifference condition for (L, k_L^*) yields

$$1 + k_L^* = \frac{\mathbb{E}[A|X=A]}{A_L}, \quad (2.31)$$

and so $k_L^* > 0$: since assets are priced above their unconditional mean, L is willing to sell them even if they are synergistic. For (2.31) to hold, we must have $1 + \bar{k} > \frac{\mathbb{E}[A|X=A]}{A_L}$, for which $1 + \bar{k} > \frac{A_H}{A_L}$ is a sufficient condition and $1 + \bar{k} > \frac{\mathbb{E}[A]}{A_L}$ is a necessary condition.

Combining (2.30) with (2.31), we have $\frac{\mathbb{E}[A|X=A]}{A_L} < 1 + \bar{k} \leq \lambda(F) \frac{\mathbb{E}[A|X=A]}{A_L}$. Since $\lambda(F^*) = 1$ and $\lambda'(F) < 0$, both conditions can be simultaneously satisfied only if $F < F^*$.

Finally, we need to show that a cutoff k_L^* actually exists at which the cutoff type (L, k_L^*) is indifferent between asset sales and equity (at which the equilibrium condition (2.31) holds). We again employ the IVT. If we specify a cutoff $1 + k'_L$ equal to the necessary lower bound $\frac{\mathbb{E}[A]}{A_L}$ on $1 + \bar{k}$, (L, k'_L) deviates to asset sales. Meanwhile, if we specify $1 + k'_L = \frac{A_H}{A_L}$, (L, k'_L) deviates to equity. Thus, a pair of sufficient conditions for existence of the equilibrium is $1 + \bar{k} \geq \frac{A_H}{A_L}$ and $1 + \bar{k} \leq \frac{E_H}{E_L} \frac{\mathbb{E}[A]}{A_L}$.

In case (iib), all H -firms issue equity and L -firms choose an interior cutoff. Assets are priced at A_L and equity is priced at $\mathbb{E}[E|X = E] > \mathbb{E}[E]$. The ND condition for H -firms is

$$1 + \underline{k} \geq \frac{A_L}{A_H} \frac{E_H}{\mathbb{E}[E|X = E]} = \lambda(F) \frac{E_L}{\mathbb{E}[E|X = E]}. \quad (2.32)$$

A sufficient condition for (2.32) is $1 + \underline{k} \geq \frac{A_L}{A_H} \frac{E_H}{\mathbb{E}[E]}$ and a necessary condition is $1 + \underline{k} > \frac{A_L}{A_H}$.

The indifference condition for (L, k_L^*) yields

$$1 + k_L^* = \frac{E_L}{\mathbb{E}[E|X = E]}, \quad (2.33)$$

and so $k_L^* < 0$. For (2.33) to hold, we must have $1 + \underline{k} < \frac{E_L}{\mathbb{E}[E|X=E]}$, for which $1 + \underline{k} \leq \frac{E_L}{E_H}$ is a sufficient condition and $1 + \underline{k} < \frac{E_L}{\mathbb{E}[E]}$ is a necessary condition. Combining (2.32) with (2.33), we have $\lambda(F) \frac{E_L}{\mathbb{E}[E|X=E]} \leq 1 + \underline{k} < \frac{E_L}{\mathbb{E}[E|X=E]}$. Since $\lambda(F^*) = 1$ and $\lambda'(F) < 0$, both conditions can be simultaneously satisfied only if $F > F^*$.

Finally, we need to show that a cutoff k_L^* actually exists at which the cutoff type (L, k_L^*) is indifferent given the resulting equilibrium valuations. We again employ the IVT. If we specify a cutoff $1 + k'_L$ equal to the necessary upper bound $\frac{E_L}{\mathbb{E}[E]}$ on $1 + \underline{k}$, (L, k'_L) deviates to equity. Meanwhile, if we specify $1 + k'_L = \frac{E_L}{E_H}$, (L, k'_L) deviates to asset sales. Thus, a pair of sufficient conditions for existence of the equilibrium is $1 + \underline{k} < \frac{E_L}{E_H}$ and $1 + \underline{k} > \frac{A_L}{A_H} \frac{E_H}{\mathbb{E}[E]}$.

In case (iia), assets are priced at A_H and equity is priced at $\mathbb{E}[E|X = E] < \mathbb{E}[E]$. The ND condition for L is $\frac{A_L(1+k)}{A_H} \geq \frac{E_L}{\mathbb{E}[E|X=E]}$, or equivalently

$$\left(1 + Pr(q = H|X = E) \frac{E_H - E_L}{E_L}\right) (1 + \underline{k}) \geq 1 + \frac{A_H - A_L}{A_L}$$

Note that $\frac{E_H - E_L}{E_L} > \frac{A_H - A_L}{A_L}$ if and only if $F < F^*$. Then the inequality is satisfied if $F \leq F^*$, $\underline{k} = 0$ and $Pr(q = H|X = E)$ is sufficiently high. $Pr(q = H|X = E)$ approaches 1 from below as $\pi \rightarrow 1$ (in the limit, there are only H firms remaining), so for π sufficiently close to 1 we can satisfy the inequality and all L firms will cooperate with the equilibrium. It remains to show that there is an equilibrium k_H^* at which type (H, k_H^*) is indifferent between selling assets and issuing equity. We again apply the IVT. First, we show that there is a candidate value k_H' at which (H, k_H') deviates to selling assets. This occurs if $1 + k_H' < \frac{E_H}{\mathbb{E}[E|X=E]}$, which will be satisfied if, for example, $k_H' = 0$. Next, we find a candidate k_H' at which (H, k_H') deviates to issuing equity: this happens if $1 + k_H' > \frac{E_H}{\mathbb{E}[E|X=E]}$. A sufficient condition for such a k_H' to exist is that potential synergies be very high: if $1 + \bar{k} > \frac{E_H}{E_L}$, then we can specify a k_H' that will deviate to equity issuance regardless of the price reaction. Then an equilibrium k_H^* exists between 0 and $\frac{E_H}{E_L}$, allowing the equilibrium to exist.

The proof for case (iib) is analogous. Assets are priced at $\mathbb{E}[A|X = A] < E[A]$ and equity is priced at E_H . The ND condition for L is $\frac{A_L(1+\bar{k})}{\mathbb{E}[A|X=A]} \leq \frac{E_L}{E_H}$, or equivalently

$$\left(1 + \frac{E_H - E_L}{E_L}\right) (1 + \bar{k}) \leq 1 + Pr(q = H|X = A) \left(\frac{A_H - A_L}{A_L}\right).$$

This will be satisfied if $F \geq F^*$, $\bar{k} = 0$, and π is sufficiently close to 1 so that $Pr(q = H|X = A)$ is also close to 1. It remains to show that an equilibrium k_H^* exists. Type (H, k_H') will deviate to asset sales if $1 + k_H' < \frac{\mathbb{E}[A|X=A]}{A_H}$. A sufficient condition for such a k_H' to exist is $1 + k_H' < \frac{A_L}{A_H}$. Type (H, k_H') will deviate to equity issuance if $1 + k_H' > \frac{\mathbb{E}[A|X=A]}{A_H}$, which is satisfied for $k_H' = 0$. Thus all the conditions stated in the lemma are sufficient for the equilibrium to exist.

In any such equilibrium, the k_q^* are defined such that type (q, k_q^*) is indifferent between asset sales and equity issuance for $q \in \{H, L\}$. Existence of the equilibrium requires that such a type exists for both q .

Proof of Proposition 1

Parts (i), (ia), and (ib) follow from the discussion of the various equilibria in Lemmas 1-3.

For (ic), we first prove $F^{EPE,IC} < F^* < F^{APE,IC}$. Suppose $F \leq F^{EPE,IC}$. This means that the IC is violated for EPE , so that $\frac{A_L(1+\bar{k})}{A_H} \geq \frac{E_L}{\mathbb{E}[E]}$. This implies $\frac{A_L}{A_H} > \frac{E_L}{E_H}$ and so $F < F^*$. Thus $F^{EPE,IC} < F^*$. Similarly, suppose $F \geq F^{APE,IC}$. This means that the IC is violated for APE , so that $\frac{E_L}{E_H} \geq \frac{A_L(1+\bar{k})}{\mathbb{E}[A]}$. This implies $\frac{E_L}{E_H} > \frac{A_L}{A_H}$, and so $F > F^*$. Thus $F^{APE,IC} > F^*$.

Next, we prove that $F^* \leq F^{APE,ND,H}$. $F^* \leq F^{APE,ND,H}$ if $F \geq F^{APE,ND,H}$ implies $F \geq F^*$; and the inequality is strict if $F \geq F^{APE,ND,H}$ implies $F > F^*$. Suppose that $F \geq F^{APE,ND,H}$, so that some H -firm would deviate under APE , i.e. $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \geq \frac{E_H}{E_L}$. If $1 + \bar{k} < \frac{\mathbb{E}[A]}{A_L}$, then $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} < \frac{A_H}{A_L}$ and thus $F > F^*$. If we only have $1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L}$, then $\frac{A_H(1+\bar{k})}{\mathbb{E}[A]} \leq \frac{A_H}{A_L}$ and thus $F \geq F^*$. Recall that $1 + \bar{k} \leq \frac{\mathbb{E}[A]}{A_L}$ was a necessary condition for APE to be sustainable, from part (i). Thus, $F^* \leq F^{APE,ND,H}$ whenever APE is sustainable, and the inequality is strict except when $1 + \bar{k}$ exactly equals $\frac{\mathbb{E}[A]}{A_L}$.

Finally, we prove $F^{EPE,ND,H} \leq F^*$. $F^{EPE,ND,H} \leq F^*$ if $F \leq F^{EPE,ND,H}$ implies $F \leq F^*$, and the inequality is strict if $F \leq F^{EPE,ND,H}$ implies $F < F^*$. Suppose $F \leq F^{EPE,ND,H}$, so that some H -firm weakly prefers to deviate under EPE , i.e. $\frac{E_H}{\mathbb{E}[E]} \geq \frac{A_H(1+\underline{k})}{A_L}$. If $1 + \underline{k} > \frac{E_L}{\mathbb{E}[E]}$, then $\frac{E_H}{E_L} > \frac{A_H}{A_L}$ and thus $F < F^*$. If we only have $1 + \underline{k} \geq \frac{E_L}{\mathbb{E}[E]}$, then $\frac{E_H}{E_L} \geq \frac{A_H}{A_L}$ and thus $F \leq F^*$. Recall that $1 + \underline{k} \geq \frac{E_L}{\mathbb{E}[E]}$ was a necessary condition for EPE to be sustainable, from part (i). Thus, whenever EPE is sustainable, we have $F^{EPE,ND,H} \leq F^*$, and the inequality is strict except when $1 + \underline{k}$ exactly equals $\frac{E_L}{\mathbb{E}[E]}$.

Taking these three points together, whenever both PE s are sustainable, $F^{EPE} \leq F^{APE}$.

The inequality is strict unless $1 + \bar{k} = \frac{\mathbb{E}[A]}{A_L}$ and $1 + \underline{k} = \frac{E_L}{\mathbb{E}[E]}$.

Point (ii) also follows from the discussion in Lemma 3.

Proof of Lemma 4

This differs from Lemma 1 in two ways: First, the r_q terms have been introduced, and second, inaction has been added to the action space for each firm. The r_q terms modify the bounds stated in (i) and (ii), but their derivation is otherwise completely analogous to that in Lemma 1. It only remains to examine any new conditions that arise due to the new available action.

The new action (inaction) is specified as an off-equilibrium-path behavior, so the equilibrium prices and actions are all the same as in Lemma 1. However, the equilibrium requires three new conditions due to the expanded action space: One each to guarantee that no H or L types deviate to inaction, and one to guarantee that the Intuitive Criterion continues to hold (that, if equity issuance is valued at H , there is some type (L, k) that will choose equity issuance over both asset sales and inaction). The Intuitive Criterion does not require any new condition governing the beliefs about an inactive firm, because we are free to specify any belief about such a firm (beliefs do not affect its payoffs).

Of these, the only nontrivial condition is the first, that no H type deviates to inaction, which gives rise to the new condition (iii). Intuitively, type H is losing some value due to the information asymmetry, so if investment incentives are very small he will eventually exit the market, as in Myers and Majluf (1984). The no-deviation-to-inaction condition is trivial for L , who benefits from both the positive-NPV investment and the market overvaluation, and the same logic implies that any L with zero or negative synergies will gladly issue equity rather than do nothing if it brings a high valuation, satisfying the Intuitive Criterion.

If $\frac{C_H + A_H}{C_L + A_L} > \frac{1 + r_H}{1 + r_L}$ holds (although we do not assume it in general), then it is still the case (as in Lemma 1) that $F^{APE, ND, H, I}$ is a tighter bound than $F^{APE, IC, I}$ if and only

if $1 + \bar{k} > \frac{\mathbb{E}[A]}{\sqrt{A_H A_L}}$. Moreover, the latter condition is equivalent to $\frac{\mathbb{E}[A]}{A_L(1+\bar{k})} > \frac{A_H(1+\bar{k})}{\mathbb{E}[A]}$. Thus, the asset-pooling equilibrium is easier to sustain than in the core model if and only if $\frac{r_H}{r_L} > \min\left(\frac{A_H(1+\bar{k})}{\mathbb{E}[A]}, \frac{\mathbb{E}[A]}{A_L(1+\bar{k})}\right)$, and is trivially sustained for any F if and only if $\frac{1+r_H}{1+r_L} > \min\left(\frac{A_H(1+\bar{k})}{\mathbb{E}[A]}, \frac{\mathbb{E}[A]}{A_L(1+\bar{k})}\right)$. The condition on $\frac{1+r_H}{1+r_L}$ is stronger than the condition on $\frac{r_H}{r_L}$ if (and only if) $r_H > r_L$.

Proof of Proposition 2

Part (ia) restates Lemma 4. Part (ib) is analogous: The *EPE* specifies the same actions and prices as in Lemma 2, and the equilibrium requires the same set of conditions (reworked to include the r_q terms), plus one additional lower bound on r_H that prevents H from deviating to inaction.

Similarly, in part (ic), we start with *SE*, which is similar to Lemma 3. L -firms will not deviate to inaction, as they are enjoying a fundamental gain and exploiting a desirable investment opportunity. A high-quality equity issuer will not deviate to inaction if

$$1 + r_H \geq \frac{E_H}{\mathbb{E}[E|X=E]}, \quad (2.34)$$

i.e., the capital loss from selling undervalued equity is less than the value of the growth opportunity. Similarly, a high-quality asset seller will not deviate if

$$1 + r_H \geq \frac{A_H(1+k_H)}{\mathbb{E}[A|X=A]}.$$

Since k_H^* is defined by $\frac{E_H}{\mathbb{E}[E|X=E]} = \frac{A_H(1+k_H^*)}{\mathbb{E}[A|X=A]}$, we have $\frac{A_H(1+k_H)}{\mathbb{E}[A|X=A]} < \frac{E_H}{\mathbb{E}[E|X=E]}$ for all asset sellers (because $k_H \leq k_H^*$). Thus, (2.34) is the applicable lower bound on r for no firm to deviate. Since $\mathbb{E}[E|X=E]$ is itself an equilibrium object, the sufficient condition in terms of model primitives is $1 + r_H > \frac{E_H}{E_L}$. For the partial *SSE* of Lemma 3, where all H -firms sell assets, the additional condition on r_H is identical.

Turning to part (ii), we start by considering the case of interior cutoffs. The definitions of

k_H^* and k_L^* in the Proposition are given by the indifference conditions. Since $1 = \frac{A_L(1+k_L^*)}{\mathbb{E}[A|X=A]}$, we have $k_L^* > 0$. L -firms will not deviate to inaction, as they are enjoying a (weakly positive) fundamental gain and exploiting a desirable investment opportunity. An inactive H -firm will not deviate to equity issuance if

$$1 + r_H < \frac{E_H}{E_L},$$

i.e., the capital loss from selling undervalued equity exceeds the value of the growth opportunity. If the above is satisfied, it is easy to show that a high-quality asset seller will not deviate either to doing nothing or to issuing equity.

Combining $1 + r_H = \frac{A_H(1+k_H^*)}{\mathbb{E}[A|X=A]}$ and $1 = \frac{A_L(1+k_L^*)}{\mathbb{E}[A|X=A]}$ yields

$$(1 + r_H) \frac{A_L}{A_H} = \frac{1 + k_H^*}{1 + k_L^*}.$$

When r_H is high (specifically, $1 + r_H > \frac{A_H}{A_L}$), we have $k_H^* > k_L^*$: H is more willing to sell assets than L because, if it switches to doing nothing, it loses the growth opportunity (whereas L continues to exploit the growth opportunity if it does not sell assets, since it issues equity instead). When $1 + r_H \leq \frac{A_H}{A_L}$, we have $k_H^* \leq k_L^*$: H is less willing to sell assets than L , because they are undervalued. Note that r_H is bounded above, since $1 + r_H < \frac{E_H}{E_L}$ for this equilibrium to hold. Thus, we have

$$1 + r_H = \frac{1 + k_H^*}{1 + k_L^*} \frac{A_H}{A_L}$$

$$\frac{E_H}{E_L} > \frac{1 + k_H^*}{1 + k_L^*} \frac{A_H}{A_L}.$$

If $\frac{E_H}{E_L} < \frac{A_H}{A_L}$ in Lemma 3, we had $k_H^* < k_L^*$; we similarly have $k_H^* < k_L^*$ here. If $\frac{E_H}{E_L} > \frac{A_H}{A_L}$ in Lemma 3, we had $k_H^* > k_L^*$. However, we need not have $k_H^* > k_L^*$. As is intuitive, giving the firms the option to do nothing makes H relatively less willing to sell assets, as he has the outside option of doing nothing.

Finally, if $1 + r_H < \frac{A_H(1+k)}{A_L}$, then all H -firms do nothing: we have a boundary cutoff. The investment opportunity is sufficiently unattractive, and dissynergies are sufficiently weak, that no H -firm wishes to sell its high-quality assets for a low price.

Proof of Lemma 5

As discussed in the text, it is trivial that H will cooperate with the equilibrium. The condition stated in the Lemma is the condition for L to cooperate. If L issues equity, it is correctly valued and the firm breaks even, while its stock price is also correct at $C_L + A_L$, so its objective function is simply $C_L + A_L$. If L deviates to selling assets, its stock price will be $C_H + A_H$, and it will receive a price of $\frac{A_L}{A_H}$ for each dollar of assets sold. L will thus cooperate with equity issuance if

$$C_L + A_L \geq \omega(C_H + A_H) + (1 - \omega) \left(C_L + A_L + F - F \frac{A_L}{A_H} \right),$$

which simplifies to the condition stated in the text.

Proof of Lemma 6

As discussed in the text, it is trivial that H will cooperate with the equilibrium. The condition stated in the Lemma is the condition for L to cooperate. If L sells assets, these are valued at the pooled price of $\pi A_H + (1 - \pi)A_L$. Similarly, its stock price is $\pi(C_H + A_H) + (1 - \pi)(C_L + A_L)$. If L deviates to issuing equity, this will be valued correctly at $C_L + A_L + F$ and its stock price will be correct at $C_L + A_L$, so its objective function is simply $C_L + A_L$. L will thus cooperate asset sales if

$$\begin{aligned} & \omega(\pi(C_H + A_H) + (1 - \pi)(C_L + A_L)) \\ & + (1 - \omega) \left(C_L + A_L + F - F \left(\frac{A_L}{\pi A_H + (1 - \pi)A_L} \right) \right) \\ & \geq C_L + A_L, \end{aligned}$$

which simplifies to the condition stated in the text.

Proof of Lemma 7

As discussed in the text, it is trivial that L will cooperate with the equilibrium. The condition stated in the Lemma is the condition for H to cooperate: If H issues equity, it is valued at $\pi(C_H + A_H + F) + (1 - \pi)(C_L + A_L + F)$, and its stock price is $\pi(C_H + A_H) + (1 - \pi)(C_L + A_L)$, since H pools with all other firms. If H deviates to selling assets, the assets sold will be valued at A_L , and its stock price will be $C_L + A_L$. Comparing the values of the objective function attained in each of these two cases, H will cooperate with the *EPE* if

$$\begin{aligned} & \omega(\mathbb{E}[C + A]) + (1 - \omega) \left(C_H + A_H + F - F \left(\frac{C_H + A_H + F}{\mathbb{E}[C + A] + F} \right) \right) \\ & \geq \omega(C_L + A_L) + (1 - \omega) \left(C_H + A_H + F - F \left(\frac{A_H}{A_L} \right) \right). \end{aligned}$$

To derive the IC condition, note that L will sell assets if inferred as H if

$$\begin{aligned} & \omega(C_H + A_H) + (1 - \omega) \left(C_L + A_L + F - F \left(\frac{A_L}{A_H} \right) \right) \\ & > \omega\mathbb{E}[C + A] + (1 - \omega) \left(C_L + A_L + F - F \left(\frac{C_L + A_L + F}{\mathbb{E}[C + A] + F} \right) \right). \end{aligned}$$

Both inequalities simplify to the conditions stated in the text.

To show that the IC condition is stronger, we compare the conditions as stated in the text.

Since $\pi > 1/2$ and so $1 - \pi < \pi$, it is sufficient to show that

$$\frac{A_L}{A_H} - \frac{C_L + A_L + F}{\mathbb{E}[C + A] + F} > \frac{C_H + A_H + F}{\mathbb{E}[C + A] + F} - \frac{A_H}{A_L}.$$

This inequality can be rearranged to

$$\frac{A_L}{A_H} + \frac{A_H}{A_L} > \frac{(C_H + A_H + F) + (C_L + A_L + F)}{\mathbb{E}[C + A] + F}.$$

The LHS takes the form $a + \frac{1}{a}$ with $a > 0$, and therefore exceeds 2. The RHS is less than 2, because $\pi > 1/2$ means that the uninformed valuation of equity (the denominator) is greater than the equal-weighted average of the high and low values (half of the numerator). Thus, the inequality holds, and so the IC condition is stronger than the ND condition.

Proof of Proposition 3

First we show $\omega^{APE} < \omega^{SE}$. To facilitate the comparison, we multiply by π the top and bottom of the bound ω^{SE} stated in Lemma 5:

$$\omega^{SE} = \frac{F \frac{\pi(A_L - A_H)}{A_H}}{F \frac{\pi(A_L - A_H)}{A_H} + \pi(C_H - C_L) - (A_L - A_H)}.$$

Now both ω^{SE} and ω^{APE} are of the form $\frac{\alpha}{\alpha+x}$, with a common value of $x \equiv (C_H - C_L) - (A_L - A_H)$. They are increasing in α since $x > 0$ (by assumption (2.1), $C_H - C_L > A_L - A_H$), so it only remains to show that the numerator of ω^{SE} is greater than that of ω^{APE} . Note that in the numerator of ω^{SE} , $\pi(A_L - A_H) = A_L - \mathbb{E}[A]$, so we wish to show $\frac{A_L - \mathbb{E}[A]}{\mathbb{E}[A]} < \frac{A_L - \mathbb{E}[A]}{A_H}$, which follows from $A_H < \mathbb{E}[A]$.

Next we show $\omega^{SE} < \omega^{EPE}$. First, since $\pi > \frac{1}{2} > 1 - \pi$, we have

$$\omega^{EPE} > \frac{F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}{\pi((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}.$$

As before, the form of the expressions involved mean that it is sufficient to show

$$\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} > \frac{\pi(A_L - A_H)}{A_H} = \frac{A_L}{A_H} - \frac{\mathbb{E}[A]}{A_H},$$

i.e., $\frac{\mathbb{E}[A]}{A_H} > \frac{E_L}{\mathbb{E}[E]}$. This holds because $A_H < \mathbb{E}[A]$ and $\mathbb{E} > E_L$.

2.7. Selling the Core Asset

2.7.1. Positive Correlation

This subsection extends the core positive correlation model of Section 2.2.1 to allow the firm to sell the core asset (in addition to the non-core asset and equity). Proposition 4 below characterizes which equilibria are sustainable and when. For simplicity of exposition, we shut down synergies ($\bar{k} = \underline{k} = 0$).

Proposition 4. *(Positive correlation, selling the core asset.) Consider a pooling equilibrium where all firms sell non-core assets ($X = A$) and a firm that sells equity or the core asset is inferred as L . The prices of core assets, non-core assets, and equity are C_L , $\pi A_H + (1 - \pi)A_L$, and $C_L + A_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:*

$$F \leq F^{APE,IC} \equiv \frac{A_L(C_H + A_H) - \mathbb{E}[A](C_L + A_L)}{\mathbb{E}[A] - A_L} \quad (2.35)$$

$$\frac{\mathbb{E}[A]}{A_L} \leq \frac{C_H}{C_L}. \quad (2.36)$$

Consider a pooling equilibrium where all firms sell core assets ($X = C$) and a firm that sells equity or the non-core asset is inferred as L . The prices of core assets, non-core assets, and equity are $\pi C_H + (1 - \pi)C_L$, A_L , and $C_L + A_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$F \leq \frac{(C_H + A_H)C_L - (C_L + A_L)\mathbb{E}[C]}{\mathbb{E}[C] - C_L} \quad (2.37)$$

$$\frac{A_L}{A_H} \leq \frac{C_L}{\mathbb{E}[C]}. \quad (2.38)$$

Consider a pooling equilibrium where all firms sell equity ($X = E$) and a firm that sells either asset is inferred as L . The prices of core assets, non-core assets, and equity are C_L , A_L , and $\pi(C_H + A_H) + (1 - \pi)(C_L + A_L) + F$, respectively. This equilibrium is sustainable

if the following conditions hold:

$$F \geq F^{EPE,IC} \equiv \frac{A_L \mathbb{E}[C + A] - A_H(C_L + A_L)}{A_H - A_L} \quad (2.39)$$

$$F \geq \frac{C_L \mathbb{E}[C + A] - C_H(C_L + A_L)}{C_H - C_L}. \quad (2.40)$$

For the *APE*, equation (2.35) is the same as (2.9) in the core model: it means that the OEPB that an equity issuer is of quality L satisfies the IC. Equation (2.36) is new and guarantees that the belief that a core asset seller is of quality L satisfies the IC. This condition is stronger than the condition that prevents H deviating to sell the core asset. For the core-asset-pooling equilibrium (*CPE*), equations (2.37) and (2.38) guarantee that the OEPB, that a seller of the non-core asset or equity is of quality L , satisfies the IC. Again, these conditions are stronger than the conditions preventing H from deviating to either of these actions.

The main result of Proposition 4 is to show that an *EPE* is still sustainable. Equations (2.39) is the same as (2.12) in the core model: it means that the OEPB that a seller of the non-core asset is of quality L satisfies the IC. Equation (2.40) is new and guarantees that the belief that a core-asset seller is of quality L is also consistent with the IC. Again, it is stronger than the condition preventing H from deviating to this action. It is possible for both inequalities to be satisfied: thus, equity issuance may be sustainable even though it does not exhibit the least information asymmetry (absent the certainty effect). One of the assets (core or non-core) will exhibit more information asymmetry than the other; since equity is a mix of both assets, its information asymmetry will lie in between. Even though equity is never the safest claim, it may still be issued, if F is sufficiently large, due to the certainty effect.

Comparing the conditions from *CPE* and *APE* that prevent H from deviating to non-core

and core assets, respectively, the former is harder to satisfy if

$$\frac{A_H}{A_L} < \frac{C_H}{C_L}.$$

Thus, as is intuitive, if the core asset exhibits greater information asymmetry, it is more difficult to sustain its sale. This result is a natural extension of Myers and Majluf (1984).

2.7.2. Negative Correlation

We now move to the negative correlation case. Proposition 5 characterizes the equilibria.

Proposition 5. *(Negative correlation, selling the core asset.) Consider a pooling equilibrium where all firms sell non-core assets ($X = A$) and a firm that sells equity or the core asset is inferred as L . The prices of core assets, non-core assets, and equity are C_L , $\pi A_H + (1 - \pi)A_L$, and $C_L + A_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:*

$$\omega \geq \frac{F \left(\frac{A_L}{E[A]} - 1 \right)}{\pi((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{E[A]} - 1 \right)}. \quad (2.41)$$

Consider a pooling equilibrium where all firms sell core assets ($X = C$) and a firm that sells equity or the non-core asset is inferred as L . The prices of core assets, non-core assets, and equity are $\pi C_H + (1 - \pi)C_L$, A_L , and $C_L + A_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$\omega \geq \frac{F \left(\frac{C_H}{E[C]} - \frac{A_H}{A_L} \right)}{\pi((C_H - C_L) - (A_L - A_H)) + F \left(\frac{C_H}{E[C]} - \frac{A_H}{A_L} \right)} \quad (2.42)$$

$$\omega \geq \frac{F \left(\frac{A_L}{A_H} - \frac{C_L}{E[C]} \right)}{(1 - \pi)((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{A_H} - \frac{C_L}{E[C]} \right)}. \quad (2.43)$$

Consider a pooling equilibrium where all firms sell equity ($X = E$) and a firm that sells either asset is inferred as L . The prices of core assets, non-core assets, and equity are C_L ,

A_L , and $\pi(C_H + A_H) + (1 - \pi)(C_L + A_L) + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$\omega \geq \frac{F \left(\frac{C_H + A_H + F}{\mathbb{E}[C + A] + F} - \frac{A_H}{A_L} \right)}{\pi((C_H - C_L) - (A_L - A_H)) + F \left(\frac{C_H + A_H + F}{\mathbb{E}[C + A] + F} - \frac{A_H}{A_L} \right)} \quad (2.44)$$

$$\omega \geq \frac{F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}{(1 - \pi)((C_H - C_L) - (A_L - A_H)) + F \left(\frac{A_L}{A_H} - \frac{E_L}{\mathbb{E}[E]} \right)}. \quad (2.45)$$

Starting with the *APE*, equation (2.41) is the ND condition for L not to deviate to equity, and is the same as equation (2.19) in the core model. If L deviates to selling the core asset, his objective function is also $C_L + A_L$ and so we have the same condition. This is intuitive: regardless of whether he deviates to the core asset or equity, the claim he issues is fairly priced as he is revealed as L . The IC condition that a seller of the core asset or equity is of quality L is trivially satisfied.

Moving to a *CPE*, L will automatically not deviate. If H deviates to sell the non-core asset, his unit cost of financing is $\frac{A_H}{A_L} < 1$, but if he deviates to sell equity, his unit cost of financing is $\frac{C_H + A_H + F}{C_L + A_L + F} > 1$. Thus, he will prefer to deviate to non-core assets, and we have the ND condition stated. The IC condition that a seller of the core asset is of quality L is again trivially satisfied; the IC condition that a seller of the non-core asset is of quality L is satisfied if (2.43) holds.

Finally, in the *EPE*, L will automatically not deviate. H will deviate to non-core assets rather than the core asset, since $\frac{A_H}{A_L} < 1 < \frac{C_H}{C_L}$, and so we have the same ND condition as before. The IC condition that a seller of the core asset is of quality L is again trivially satisfied; the IC condition that a seller of the non-core asset is of quality L is satisfied if

(2.45) holds. Equation (2.45) is stronger than (2.41), the *APE* lower bound, if and only if:

$$\begin{aligned} \pi \left(\frac{A_L}{A_H} - \frac{C_L}{\mathbb{E}[C]} \right) &> (1 - \pi) \left(\frac{A_L - \mathbb{E}[A]}{\mathbb{E}[A]} \right) \\ \pi \left(\frac{C_L}{\mathbb{E}[C]} \right) &< \frac{\pi A_L \mathbb{E}[A] - (1 - \pi) A_H (A_L - \mathbb{E}[A])}{A_H \mathbb{E}[A]}. \end{aligned}$$

Since $C_L < \mathbb{E}[C]$, it is sufficient that

$$\begin{aligned} \pi A_H \mathbb{E}[A] &< \pi A_L \mathbb{E}[A] - (1 - \pi) A_H (A_L - \mathbb{E}[A]) \\ 0 &< (A_L - A_H) \pi \mathbb{E}[A] - (1 - \pi) A_H (A_L - \mathbb{E}[A]), \end{aligned}$$

which is true since $\pi > 1 - \pi$, $(A_L - A_H) > (A_L - \mathbb{E}[A])$, and $\mathbb{E}[A] > A_H$.

Thus, the *APE* is easier to sustain than the *CPE*. This is a simple extension of the camouflage effect of the core model. A deviation from the *APE* to either the core asset or equity is relatively unattractive, since the firm suffers a “lemons” discount on both the security being issued and the rest of the firm as a whole. This is because both the core asset and equity are positively correlated with the value of the firm. In contrast, a deviation from either the *CPE* or the *EPE* to selling the non-core asset is harder to rule out: even if a high price is received for the non-core asset, this does not imply a high valuation for the firm as a whole, and so it is difficult to satisfy the IC.

The *SEs* are very similar to the core model. As in the core model, there is a *SE* where H sells non-core assets and L issues equity. There is also a *SE* where H sells non-core assets and L sells core assets. The conditions for this equilibrium to hold are exactly the same as in the core model. In both equilibria, by deviating, L 's stock price increases but his fundamental value falls by $\frac{F(A_L - A_H)}{A_H}$. Regardless of whether L sells equity or core assets in the *SE*, deviation involves him selling his highly-valued non-core assets and thus suffering a loss. There is no *SE* where H sells core assets and L sells equity, or when H sells equity or L sells the core asset, since L will mimic H in both cases. The only possible *SE* is where

H sells non-core assets, as L will not wish to mimic him as this will involve selling assets at a fundamental loss.

2.7.3. A Three-Asset Model

The previous sub-section showed that, in the case of negative correlation, it is easier to sustain an equilibrium in which all firms sell the non-core asset than one in which all firms sell the core asset. While this result is suggestive of the correlation effect, it may also arise from the fact that the non-core asset exhibits less information asymmetry, because $A_L - A_H < C_H - C_L$. If we reversed this assumption, then firm value would be higher for L than H , and so we would have the same model but with reversed notation. Since firm value is higher for L , then L is effectively H . Since A is positively correlated with firm value, A is effectively C and C is effectively A . We will obtain the result that it is easier to sustain a CPE than an APE , but this would be because C exhibits less information asymmetry rather than C being negatively correlated.

Thus, to allow for both positively and negatively correlated assets, and also for either asset to exhibit higher information asymmetry, we need to move to a 3-asset model. Let the three assets be C , P , and N . Asset C cannot be sold as it is the core asset, but assets P and N can be. Asset P is the positively correlated asset ($P_H \geq P_L$) and asset N is the negatively correlated asset ($N_H \leq N_L$). We allow for both $P_H - P_L > N_L - N_H$ and $P_H - P_L < N_L - N_H$: either asset may exhibit more information asymmetry. We only assume $C_H + P_H + N_H > C_L + P_L + N_L$: the existence of the third asset C means that H has a higher firm value than L , even if N exhibits more information asymmetry than P . Let $A = P + N$ be the total value of the two non-core assets.

Proposition 6 characterizes the equilibria.

Proposition 6. (*Three-asset model.*) *Consider a pooling equilibrium where all firms sell the negatively-correlated asset ($X = N$) and a firm that sells equity or the positively-correlated asset is inferred as L . The prices of the positively-correlated asset, negatively-correlated*

asset, and equity are P_L , $\pi N_H + (1 - \pi)N_L$, and $C_L + P_L + N_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$\omega \geq \frac{F \left(\frac{N_L}{\mathbb{E}[N]} - 1 \right)}{\pi (E_H - E_L) + F \left(\frac{N_L}{\mathbb{E}[N]} - 1 \right)}. \quad (2.46)$$

Consider a pooling equilibrium where all firms sell the positively-correlated asset ($X = P$) and a firm that sells equity or the negatively-correlated asset is inferred as L . The prices of the positively-correlated asset, negatively-correlated asset, and equity are $\pi P_H + (1 - \pi)P_L$, N_L , and $C_L + P_L + N_L + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$\omega \geq \frac{F \left(\frac{P_H}{\mathbb{E}[P]} - \frac{N_H}{N_L} \right)}{\pi (E_H - E_L) + F \left(\frac{P_H}{\mathbb{E}[P]} - \frac{N_H}{N_L} \right)} \quad (2.47)$$

$$\omega \geq \frac{F \left(\frac{E_L}{E_H} - \frac{P_L}{\mathbb{E}[P]} \right)}{(1 - \pi) (C_H - C_L + A_H - A_L) + F \left(\frac{E_L}{E_H} - \frac{P_L}{\mathbb{E}[P]} \right)}. \quad (2.48)$$

Consider a pooling equilibrium where all firms sell equity ($X = E$) and a firm that sells either asset is inferred as L . The prices of the positively-correlated asset, negatively-correlated asset, and equity are P_L , N_L , and $\pi (C_H + P_H + N_H) + (1 - \pi) (C_L + P_L + N_L) + F$, respectively. This equilibrium is sustainable if the following conditions hold:

$$\omega \geq \frac{F \left(\frac{N_L}{N_H} - \frac{E_L}{\mathbb{E}[E]} \right)}{(1 - \pi) (C_H - C_L + A_H - A_L) + F \left(\frac{N_L}{N_H} - \frac{E_L}{\mathbb{E}[E]} \right)} \quad (2.49)$$

$$\omega \geq \frac{F \left(\frac{E_H}{\mathbb{E}[E]} - \frac{N_H}{N_L} \right)}{\pi (C_H - C_L + A_H - A_L) + F \left(\frac{E_H}{\mathbb{E}[E]} - \frac{N_H}{N_L} \right)} \quad (2.50)$$

Starting with the N -pooling equilibrium, H will not deviate; equation (2.46) gives the condition for L not to deviate to either equity or P . The IC conditions that L will deviate to P or equity if it were revealed good are trivially satisfied. L would make a capital

gain on selling low-quality P or low-quality equity, compared to its capital loss on selling high-quality N , and enjoy a higher stock price.

Moving to the P -pooling equilibrium, L will not deviate. H will always deviate to sell N rather than equity, and equation (2.47) is the ND condition for him not to do so. Equation (2.48) is the IC condition for L to be willing to deviate to equity if he were revealed good, which is stronger than the IC condition for deviation to N .

The IC condition for the P -pooling equilibrium (equation (2.48)) is stronger than the ND condition for the N -pooling equilibrium ((2.46)) if and only if

$$\pi \left(\frac{N_L}{N_H} - \frac{P_L}{\mathbb{E}[P]} \right) > (1 - \pi) \left(\frac{N_L}{\mathbb{E}[N]} - 1 \right).$$

This always holds, since $\pi > 1 - \pi$, and $\frac{N_L}{N_H} > \frac{N_L}{\mathbb{E}[N]}$, and $\frac{P_L}{\mathbb{E}[P]} < 1$. Thus, it is easier to sustain an equilibrium in which all firms sell negatively-correlated assets than one in which all firms sell positively-correlated assets, due to the correlation effect.

Finally, for the EPE , L will not deviate. There are two IC conditions, one to ensure deviation to P and one to N , but the latter condition is stronger and is the first of the two conditions listed. There are similarly two ND conditions for H , one to prevent deviation to P and the other to N , but again the latter is stronger and is the second of the two conditions listed. The ND condition for L is trivial. Since every type has the potential to deviate to an asset that will be valued highly, we require high stock price concerns to deter such a deviation.

2.8. Financing from Multiple Sources

The core model assumes that firms can only raise financing from a single source. One potential justification is that the transactions costs from using multiple sources of financing are prohibitive. Alternatively, the assumption can be endogenized with the OEPB that any firm that issues multiple financing sources is of quality L . This section studies whether this

belief satisfies the IC.

For three of the four pooling equilibria studied in the paper, our existing IC condition (that L would deviate to a claim consisting entirely of the off-equilibrium security choice, if valued as H by doing so) is already sufficient to achieve the new desired result (that L would deviate to *any* mixture of asset sales and equity issuance, if valued as H by doing so). For the equilibria in the positive correlation model, this happens because L receives a high price for both components of the mixture, instead of receiving a pooled price from cooperating with the pooling equilibrium. For the *EPE* in the negative correlation model, L receives a low price if he deviates to sell assets and is inferred as H , but this loss will be lower if he mixes the asset sale with an equity issue, since the latter will fetch a high price. Thus, his fundamental value is higher when selling the mixture than when selling assets only. As a result, the existing IC condition, which guarantees that he will deviate to assets if inferred as H , ensures that he will deviate to any mixture if inferred as H .

For the *APE* in the negative correlation model, we require an additional condition (a lower bound on ω , given in (2.51) below) to ensure that the IC condition is satisfied. This additional condition is only necessary because, unlike the other three pooling equilibria, this pooling equilibrium required no IC condition in the core model. It was automatic that L would deviate to pure equity if he was inferred as H , since he avoids the capital loss from selling high-quality assets and also enjoys a high stock price. When financing mixtures are possible, there may be mixtures that comprise such a high proportion of asset sales that L would suffer a large fundamental loss by selling this mixture and so will not deviate despite enjoying a high stock price. This is the case we rule out with (2.51) below; the results and economic intuition of the model do not change in response to this new condition.

We now proceed with formal proofs of the above statements. As in the previous section, we maintain $\bar{k} = \underline{k} = 0$ for simplicity. Consider a deviation by L to raise αF from asset sales and $(1 - \alpha) F$ from equity issuance. We wish to study whether, if he is inferred as H from such a deviation, his payoff is higher than in the pooling equilibrium, for any α . We

consider the four pooling equilibria in turn.

Positive correlation, APE. The existing IC condition (2.9) implies that L 's capital gain from selling equity at a high price (if he deviates and is inferred as H) exceeds his gain from selling assets at a pooled price in the pooling equilibrium:

$$\frac{E_L}{E_H} \leq \frac{A_L}{\pi A_H + (1 - \pi) A_L}$$

We wish to show that his gain from selling any mix of assets and equity at a high price exceeds his gain from selling assets at a pooled price:

$$\alpha \frac{A_L}{A_H} + (1 - \alpha) \frac{E_L}{E_H} \leq \frac{A_L}{\pi A_H + (1 - \pi) A_L}$$

The existing IC condition (2.9) establishes the inequality for $\alpha = 0$. The LHS is linear in α , and for $\alpha = 1$ it simplifies to $\frac{A_L}{A_H} \leq \frac{A_L}{\mathbb{E}[A]}$, which holds because positive correlation implies $A_H > \mathbb{E}[A]$. Thus, the inequality is satisfied for all $\alpha \in [0, 1]$.

Positive correlation, EPE. We wish to show that, for all α :

$$\alpha \frac{A_L}{A_H} + (1 - \alpha) \frac{E_L}{E_H} \leq \frac{E_L}{\mathbb{E}[E]}$$

The LHS is again linear in α . The IC condition (2.12) in the core model establishes the inequality for $\alpha = 1$, and for $\alpha = 0$ the LHS simplifies to

$$\frac{E_L}{E_H} \leq \frac{E_L}{\mathbb{E}[E]},$$

which always holds. Thus, the inequality is satisfied for all $\alpha \in [0, 1]$.

Negative correlation, APE. We wish to show that, for all α :

$$\begin{aligned} & \omega \mathbb{E}[C + A] + (1 - \omega) \left(C_L + A_L + F - F \left(\frac{A_L}{\mathbb{E}[A]} \right) \right) \\ & \leq \omega (C_H + A_H) + (1 - \omega) \left(C_L + A_L + F - F \left(\alpha \frac{A_L}{A_H} + (1 - \alpha) \frac{E_L}{E_H} \right) \right) \end{aligned}$$

We can rearrange this condition to $\omega \geq \frac{MF}{\kappa + MF}$, where $\kappa \equiv (C_H - C_L) - (A_L - A_H)$ and M is defined appropriately. For $\alpha = 0$, $M < 0$ and the lower bound on ω is negative, which is why the IC condition was trivial in the core model. However, the derivative of the bound with respect to α is positive: it equals the sign of $\frac{\partial M}{\partial \alpha}$, which is positive since $A_L > A_H$ under negative correlation. Thus, as α increases, the lower bound on ω rises and can eventually become positive and constitute a nontrivial IC condition. Intuitively, if L is inferred as H , his capital loss to selling assets is higher than under the pooling equilibrium, since he receives a low price (A_H) rather than a pooled price. Thus, financing mixes that are primarily comprised of assets (high α) are particularly costly to him and he may be unwilling to deviate even if he is inferred as H . To ensure that L is willing to deviate for all α , we require the condition to be satisfied for $\alpha = 1$. This in turn requires:

$$\omega \geq \frac{F \left(\frac{A_L}{A_H} - \frac{A_L}{\mathbb{E}[A]} \right)}{(C_H - C_L) - (A_L - A_H) + F \left(\frac{A_L}{A_H} - \frac{A_L}{\mathbb{E}[A]} \right)}. \quad (2.51)$$

To encourage deviation, L must have a high weight on the stock price to offset his capital loss from asset sales. Condition (2.51) is stronger than (2.19) (the ND condition for *APE*) if and only if $(1 - \pi)A_L > A_H$, which is not imposed or ruled out by any of our assumptions thus far. Thus, if $(1 - \pi)A_L > A_H$, the additional condition (2.51) is needed for the OEPB, that an issuer of multiple financing sources is of quality L , to satisfy the IC.

Negative correlation, EPE. We wish to show that, for all α :

$$\begin{aligned} & \omega \mathbb{E}[C + A] + (1 - \omega) \left(C_L + A_L + F - F \left(\frac{E_L}{\mathbb{E}[E]} \right) \right) \\ & \leq \omega(C_H + A_H) + (1 - \omega) \left(C_L + A_L + F - F \left(\alpha \frac{A_L}{A_H} + (1 - \alpha) \frac{E_L}{E_H} \right) \right). \end{aligned}$$

The existing IC condition (2.20) establishes the inequality for $\alpha = 1$. The derivative of the RHS with respect to α is

$$-F(1 - \omega) \left[\frac{A_L}{A_H} - \frac{E_L}{E_H} \right] < 0.$$

Thus, as we decrease α from 1 to 0, the RHS increases and the inequality continues to be satisfied.

2.9. Cash Used For Investment: Additional Material

This section provides additional material relevant to Section 2.2.2. We maintain $\bar{k} = \underline{k} = 0$ throughout.

2.9.1. Positive Correlation, Positive-NPV Investment, EPE

We first start by analyzing an *EPE*, for the case of positive correlation and positive-NPV investment. The effect of using cash for investment is similar to the *APE* case of the core model. Intuitively, it may seem that this usage will always make an *EPE* harder to satisfy because the volatility of the investment reduces the certainty effect. However, if r_H is close to r_L , this volatility effect is outweighed by the fact that the investment is positive-NPV. The equilibrium is given in Lemma 9 below.

Lemma 9. (*Positive correlation, pooling equilibrium, all firms sell equity, cash used for investment.*) Consider a pooling equilibrium where all firms sell equity ($X = E$) and an asset seller is inferred as L . The prices of assets and equity are A_L and $\pi(C_H + A_H + F(1 + r_H)) + (1 - \pi)(C_L + A_L + F(1 + r_L))$, respectively. This equilibrium is sustainable if $\frac{1 + \mathbb{E}[r_q]}{1 + r_L} < \frac{A_H}{A_L}$

and

$$F(A_H(1+r_L) - A_L(1+\mathbb{E}[r_q])) \geq A_L\mathbb{E}[C+A] - A_H(C_L+A_L). \quad (2.52)$$

where $\mathbb{E}[r_q] = \pi r_H + (1-\pi)r_L$.

This condition can be rewritten $F > F^{EPE,IC}$, where $F^{EPE,IC} \equiv \frac{A_L\mathbb{E}[C+A] - A_H(C_L+A_L)}{A_H(1+r_L) - A_L\mathbb{E}[1+r_q]}$

Proof. We start with the ND condition. By pooling, type H 's fundamental value is

$$C_H + A_H + R_H - F\left(\frac{C_H + A_H + R_H}{\mathbb{E}[C + A + R]}\right).$$

By deviating, it becomes:

$$C_H + A_H + R_H - F\left(\frac{A_H}{A_L}\right).$$

Thus, he will not deviate if:

$$F[A_H(1+E[r_q]) - A_L(1+r_H)] \geq A_L(C_H + A_H) - A_H\mathbb{E}[C + A]$$

where

$$\mathbb{E}[r_q] = \pi r_H + (1-\pi)r_L.$$

We now move to the IC condition. By pooling, type L 's fundamental value is

$$C_L + A_L + R_L - F\left(\frac{C_L + A_L + R_L}{\mathbb{E}[C + A + R]}\right).$$

By deviating to asset sales and being inferred as type H , it becomes:

$$C_L + A_L + R_L - F\left(\frac{A_L}{A_H}\right).$$

Thus, he will deviate if:

$$F [A_H(1 + r_L) - A_L (1 + E [r_q])] > A_L \mathbb{E}[C + A] - A_H(C_L + A_L).$$

This completes the derivation of the ND and IC lower bounds respectively. Note that (2.15) implies that the RHS of both conditions is positive. If $\frac{1+r_H}{1+\mathbb{E}[r_q]} > \frac{A_H}{A_L}$, the LHS of both conditions is negative, so the equilibrium will not be sustainable for any F (the lower bound on F is ∞). If $\frac{1+\mathbb{E}[r_q]}{1+r_L} > \frac{A_H}{A_L} > \frac{1+r_H}{1+\mathbb{E}[r_q]}$, the left side of the ND condition becomes positive but the LHS of the IC condition is still negative, so the equilibrium still is not sustainable. Only if $\frac{A_H}{A_L} > \frac{1+\mathbb{E}[r_q]}{1+r_L}$ does it become possible to satisfy both conditions. To facilitate comparison with Lemma 4, this can be rewritten as follows:

$$\frac{A_H}{A_L} > \frac{1 + \mathbb{E}[r_q]}{1 + r_L} \iff \frac{1 + r_H}{1 + r_L} < \frac{A_H - (1 - \pi)A_L}{\pi A_L}$$

The bound is greater than the corresponding quantity $\frac{\mathbb{E}[A]}{A_L}$ in the Lemma. To show that the lower bound on F implied by the IC condition is stronger than that implied by the ND condition, one can directly compare them and derive that the ND bound is stronger if and only if $\frac{1+r_H}{1+r_L} > \frac{C_H+A_H}{C_L+A_L}$. This level of volatility in r_q is incompatible with the existence of the equilibrium: For existence, we need $\frac{1+\mathbb{E}[r_q]}{1+r_L} < \frac{A_H}{A_L}$, and from (2.15) this implies $\frac{1+\mathbb{E}[r_q]}{1+r_L} < \frac{C_H+A_H}{\mathbb{E}[C+A]}$. Since $\pi > 1/2$ we have $\frac{C_H+A_H}{\mathbb{E}[C+A]} < \frac{\mathbb{E}[C+A]}{C_L+A_L}$, so existence implies $\frac{1+\mathbb{E}[r_q]}{1+r_L} < \frac{\mathbb{E}[C+A]}{C_L+A_L}$, which in turn implies $\frac{1+r_H}{1+r_L} < \frac{C_H+A_H}{C_L+A_L}$, implying that the IC condition is always the stronger condition. ■

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